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MEDICINE IN SHAKESPEARE'S WRITINGS

Shakespeare and Medicine

By R. R. Simpson. Pp. vii+267. (Edinburgh and London: E. and S. Livingstone, Ltd., 1959.) 25*s*. net.

ACCORDING to Chambers's bibliography on authorities on books on Shakespeare, comprising some 450 volumes, only one deals with the medical aspect of Shakespeare's writings, that by Dr. John Bucknill, which appeared just a century ago. The present book by Mr. Simpson is therefore opportune. It is based on lectures to various medical societies and its object is "to record the medical references in the plays and poems, to assess Shakespeare's knowledge of the medicine of his day, to consider the uses to which he put it and to discuss some of the possible sources of his medical knowledge". Although the study was undertaken primarily from the medical point of view, it should be of interest to the literary reader even though it makes no purely literary contributions. Any fresh study of Shakespeare is of interest and value.

The author has collected more than seven hundred medical references, major and minor, and classifies them under twenty pertinent headings. The discussion of these entails some overlap and consequent repetition which detracts from the interest if the book is read as a whole. This drawback would not appear if various sections were used for reference or for lectures.

Mr. Simpson emphasizes that Shakespeare often uses a medical image to illustrate a point, or a medical situation at a moment of dramatic intensity. Among notable passages he recalls is the brilliant description of death in the typhoid state as it befalls Falstaff in "Henry V". Also the quite remarkable description of tertiary syphilis in "Timon of Athens", IV, 3.

It is not possible to say whether Shakespeare was acquainted with the literature of contemporary Elizabethan medicine, but that he was certainly aware of current medical thought is evident from numerous quoted passages. This inevitably leads to the question of how much Shakespeare learned from and was influenced by Dr. John Hall, the physician who married his daughter and who lived and practised in Stratford. In an interesting chapter on this subject, Mr. Simpson proves quite definitely from a chart giving the plays in their chronological order and the numbers of medical references in each that any influence must have been slight. Hall did not enter Shakespeare's life until 1600, and up to that year the plays contain 215 major medical references; after 1600 there are 225.

Shakespeare's references to almost all aspects of human activity and life are so rich and so strikingly apt that one could make a fair comparison with almost any important profession or calling just as with medicine, and this would not necessarily imply he had special connexions. His genius enabled him to embrace so much with clarity, ease and conviction.

Any doctor with literary interests will profit by reading this book. Any non-medical student of Shakespeare should be familiar with its presentation of an important aspect of the plays and poems. It is a good reference book for the doctor and a useful bedside book also.

RUSSELL BROCK

THE ROYAL COLLEGE OF SURGEONS OF ENGLAND

The Royal College of Surgeons of England

A History. By Sir Zachary Cope. Pp. xii+360+78 figures. (London: Anthony Blond, Ltd., 1959.) 63*s*.

SINCE his retirement from active surgery, Sir Zachary Cope has become a well-known and trusted public servant. He has also produced a series of learned writings on the history of his own profession, not the least of which is the surgical record of the Second World War. In all these works he has shown good sense, good temper and good judgment. Here he displays these qualities towards a famous corporation of which he has long been a prominent member. Its story is by no means one of continual progress nor always even wholly edifying, yet he makes no attempt to cover the bad patches. But the record has had a happy development in the last generation under the guidance of men of temperament comparable to that of the author himself.

It must be remembered that until about a hundred years ago, in England—and in England alone of the Western countries not excluding Scotland and Ireland—serious instruction in the practice of medicine was not held to be any part of the duty of our ancient universities. These had, of course, nominal professors of medicine, of anatomy, and of other para-medical subjects, but their teaching—so far as it existed—was of book-learning and not on practical lines. By this time certain of the 'new universities' were giving medical degrees. But before the rise of the new universities, almost the usual way to become an effective practitioner was through apprenticeship to a surgeon with the view of becoming a Member of the Royal College of Surgeons of London. This body was instituted as such in 1800. To it were consigned, by Act of Parliament, the magnificent collections of John Hunter.

The College thus constituted had a very defective constitution. Its Council was self-elected and elected for life. It thus came to consist largely of aged and often eccentric men, though it also contained some of the highest eminence. This Council acted as examiners, and the examination was entirely oral. There was not even a syllabus for several decades. The result of all this was that the process became a rather sour joke. Mr. Bob Sawyer and Mr. Benjamin Allen must have been fairly average students of those bad old days. The process of transforming the

type of student began when the Society of Apothecaries, in 1815, succeeded in becoming incorporated and introducing a reasonable examination of its own. About this time the term 'general practitioner' was introduced. The best qualification for such men was membership of the Royal College of Surgeons and licentiate of the Society of Apothecaries (M.R.C.S., L.S.A.). The weakest point in the curriculum was inadequate attention to what is now called 'internal medicine'. Yet such are the delaying possibilities of institutions that it was not until 1885 that the Royal College of Physicians joined the Royal College of Surgeons in establishing a 'Conjoint Board', the diploma of which (M.R.C.S., L.R.C.P.) covered all aspects of general practice. This became the standard qualification of such gentlemen until the beginning of the present century.

The major operations of surgery were naturally always undertaken mainly by a special class, usually attached to teaching hospitals. The status both of these and of the College itself was raised by a charter of 1843 under which certain Members of the College became Fellows. This distinction was conferred from 1844 onward by a special examination, and the diploma F.R.C.S. remains evidence of high competence in the art and was almost necessary for the coveted 'honorary' surgical appointments at the larger hospitals. These Fellows themselves elected the Council, membership of which became, in itself, a high professional distinction.

In the early twentieth century it looked as though the medical degrees of the new universities might take the place of the diplomas of the Conjoint Board, and this process is continuing. But under the wise and genial leadership of the late Lord Webb-Johnson, who presided over the College of Surgeons from 1941 until 1948, that institution was transformed from being mainly a diploma-granting body into one of higher surgical education. It has since attracted great numbers of students, especially of those who seek the diploma of F.R.C.S., and has become the chief place in Britain and, indeed, of the Commonwealth, for the training of such men. Thus the functions of the College have become largely, if not mainly, changed almost beyond recognition.

Sir Zachary's account of the College is supplemented by one of its great library by its librarian, Mr. W. R. LeFanu, and of John Hunter's Museum by its anatomical curator, Miss Jessie Dobson, who knows more about that institution than anyone living. The importance of the Hunterian Museum can be judged by recalling that its staff has included Richard Owen, Arthur Keith, Frederick Wood Jones and many other great men of science. Sir Zachary has provided a readable and often amusing account of a great and characteristic national institution.

Charles Singer

EARLY SCIENCE IN CHINA

Science and Civilization in China

By Dr. Joseph Needham, with the collaboration of Dr. Wang Ling. Vol. 3: Mathematics and the Sciences of the Heavens and the Earth. Pp. xlvii+877+plates 21–95. (Cambridge: At the University Press, 1959.) 150*s*. net.

THE first two volumes of this monumental work introduced the reader to the intellectual background of scientific thought in China from the earliest times to, roughly, the Newtonian era; in this third volume Dr. Needham discusses in great detail the beginnings and developments of Chinese mathematics and natural science within the same temporal span. To many students of the history and philosophy of science, this volume will be a revelation of the achievements of a civilization isolated almost entirely from Western and other Eastern influences until the arrival of Jesuit missionaries at the end of the sixteenth century. For this immense and astonishing work of erudition no praise can be too high; the author has an impressive knowledge of Chinese culture to add to his eminence in the field of natural science; and so we have a volume authoritative, fascinating and illuminating, sure in the unravelling of the complexities of the evidence, and with a shrewd appraisal, on appropriate occasions, of contemporary Eastern and Western progress in the sciences.

First and briefly as to the section on mathematics. Dr. Needham points out that, whereas Greek mathematics was deductive in character, particularly in geometry, the Chinese approach was mainly arithmetical and algebraic in essence and concerned to a large extent with utilitarian problems in mensuration, the calendar and so on. It is not surprising that, handicapped as they were by an unwieldy notation, the Chinese were unable to develop purely algebraic—as distinct from arithmetical—methods in dealing with such problems as the solution of quadratic and cubic equations and the method of finite differences. But, within these limitations, their progress was anything but negligible, however uninterested as they apparently were in abstract inquiries.

The longest section of the book is on astronomy; here the story is different, and a complete refutation of the dogmatic and ill-informed statement of Whewell, the famous Master of Trinity, who declared a little more than a century ago that: "We find no single observation, or fact, connected with astronomy in the Chinese histories, and their astronomy has never advanced beyond a very rude and imperfect condition". A substantially similar statement appears in a very recent "History of Astronomy". The fact is that, as Needham says and as is borne out by the evidence, the Chinese were the most persistent and accurate observers of celestial phenomena anywhere in the world. It is noteworthy that for several centuries before the tenth century A.D. the Chinese astronomical records are the only ones available; again, Laplace paid considerable attention to the ancient and medieval determinations of the obliquity of the ecliptic—the oldest going back several centuries B.C.—in his researches on the secular changes in the obliquity.

Chinese astronomy differed in one marked respect from Greek astronomy. In the latter, the ecliptic was the fundamental plane, for the main interest centred on the positions and movements of the Sun, Moon and planets, the stars being relegated to a hypothetical crystalline sphere. The Chinese, on the other hand, adopted the celestial equator as the fundamental plane for their observations, particularly of circumpolar stars; from this followed two important advances in instrumental design. First, the invention of the equatorial mounting applied to such instruments as the armillary sphere, and second—and most remarkable—the invention in A.D. 132 of the clock-drive, when an armillary sphere was rotated by means of a water-wheel controlled by a clepsydra or water-clock. Against this, the choice of the equatorial system of co-ordinates—and most of all, the non-

deductive character of their mathematics—militated against any real progress being made in the understanding of planetary motions.

Large number of eclipses were recorded in Chinese annals from 720 B.C. onwards, and the dates of many of these have been corroborated in recent times, to the great advantage of modern studies.

We owe to Chinese (and Japanese) astronomers the recording of the first super-nova (now identified with the Crab Nebula) which, at its brightest was visible in daylight. Novæ, the earliest of which was observed about 1300 B.C., were described as 'guest-stars' and as such were believed to show the approval of the heavens for the dynasty in power.

Bare mention can only be made of the observations of sunspots, comets, meteors and meteorites, variable stars and, in the final sections of the book, to the study of meteorological phenomena, cartography, seismology (including the earliest known form of seismograph), palæontology and mineralogy.

In conclusion, one can only refer in a word to the magnificent photographs which lavishly adorn the book.

W. M. SMART

HERBERT SPENCERISM

The Integration of Human Knowledge

A Study of the Formal Foundations and the Social Implications of Unified Science. By Prof. Oliver L. Reiser. Pp. xvi+478. (Boston, Mass.: Porter Sargent Publisher, 1958.) 8 dollars.

HERBERT SPENCERISM is the persistent and mistaken idea that apart from particular scientific investigations for particular purposes there is yet another subject, a super-science, which consists in doing something with the results of these special investigations. Reiser wants to have colleges of integration, staffed by people doing this. The trouble is that it is never made clear what they would be doing. Scientists investigate definite hypotheses, but what would super-scientists do? Would they produce and synthesize abstracts all day, and if they did, what exactly would this work of synthesis be? Reiser complains that in previous centuries universities used to do this synthesizing but that now they fall short of it. But surely all that has happened is that so much more has been found out. This raises no problem other than that of getting an efficient abstracting service.

It is not possible to gather what Reiser means by 'integration', either from his precept or his practice. He defines integration as the extraction of common principles from the special sciences and the use of these in developing a universal world view (p. 387). This sounds like a proposal to use methodology for the purpose. But he also tells us that integration has a social basis, namely, cultural unity, and it is not easy to see how the study of methodology could give rise to cultural unity. To tell us that the social basis of integration is cultural unity is to tell us that when people think alike they think alike. This brings us no nearer to an understanding of his use of 'integration'. Elsewhere integration is defined as putting together information from different fields; and the task of philosophy is defined as that of integration (p. 7). It follows that a philosophical problem is a problem about how to put bits of information together. But the integration, we are told, has to be based on the use of materials from those fields which are relevant to the philosophical problem. So the integration has to be based on what is relevant to the integration. This tells us nothing.

The book itself is cited as an example of integration. It should be possible, therefore, to gather what is meant by the term by looking at Reiser's own practice. The plan of the book is to pass chapter by chapter from the foundations of knowledge (logic, mathematics, methodology, semantics, epistemology) through the special sciences to a final synthesis. In each chapter the main points of view on a given field are outlined and then 'synthesized'. Again, reading the results of this procedure brings us no nearer to an understanding of Reiser's use of 'integration'. For his procedure is that of eclectic collation of views based upon his own approval and disapproval.

It might be asked why we need this synthesis. Reiser's answer is that it is essential for the establishment of a unified world society. He admits that it is also essential that the Russians should adopt his views. He says that society will remain confused until we know the answer to the question "What is knowledge for?" and that this question cannot be answered until our knowledge is complete (p. 258). But in that case, the question never will be answered. We do, in fact, already know the answer. For knowledge is valued both as a means and as an end. We need no institute of integration in order to find this out. We also know that a question as general as this will admit of an answer only in equally general terms. If this is felt to be unsatisfactory, the solution is not to produce yet further verbalisms but to ask more specific questions.

There is a unity of science already, all the unity that there need be. All that is needed to obtain it in any given case is to get a group of specialists working together on one project. It is up to those who say that such a group stands in need of further 'unification' to specify intelligibly what they mean. The fallacy involved in the demand for synthesis is a Platonic fallacy. It is the view that knowledge is contemplative; that in order to 'know' science someone has to acquire and put together (in a manner which is never specified) all the results from all the sciences. But science consists in the exercise of certain manual and conceptual skills, and the unification of these skills is attained by the co-operation of specialists for definite purposes. There is nothing else in the way of synthesis to be done. Reiser's book illustrates the effects of nevertheless trying to do it.

JOHN TUCKER

HUMAN RITES

The Rites of Passage

By Arnold van Gennep. Translated by Monika B. Vizedom and Gabrielle L. Caffee. Pp. xxvi+198. (London: Routledge and Kegan Paul, Ltd., 1960.) 23*s*. net.

FOR many years the author of this book was professor of ethnography in the University of Neuchâtel and particularly well known as an authority on popular traditions, legends and folk-lore. In 1909 he published his ideas on these subjects in a book entitled "The Rites of Passage" and this arresting title has now established for itself a place in the vocabulary of the anthropologists. In our

journey through space-time we have to pass through many passages which lead from one period in our lives to another period. For example, there are the passages from infancy to childhood, from childhood to adolescence, adolescence to adulthood, and finally the abrupt passage through the doorway of death, either to annihilation or to an entirely different form of life beyond the grave.

Gennep has noted two facts about these transition periods of man's life. The first is that each of these movements has its appropriate rules and rites and that the ceremonies which accompany them are very much the same in all civilizations and cultures. He also directs attention to the fact that these cultures accentuate the existence of two particularly sharp divisions in society, the first being the sexual division between the men and the women and the second the magico-religious division between the religious members of society and the profane members. He gives a description also of the secondary groupings of the various age-groups, the family units and the politico-administrative and territorial units.

Life entails for everybody many separations followed by subsequent re-unions, and one of the author's main purposes in writing this book was to investigate the precise significance of the rites which are, and which always have been, associated with these passages of separation and re-union. This led him to investigate the various initiation rites in the mystery religions of Egypt and Greece, religions which exerted a great influence on the ceremonies and rituals of the Christian Church in its early formative years. Indeed, it may be said that the rituals of the Catholic Mass are representations of a number of transitions and incorporations, the only difference between these and the initiation rituals of the old mystery religions being that the initiation ceremonies of the Mass are never final but are always being renewed.

Arnold van Gennep's book covers a great deal of ground, and it should be of interest not only to anthropologists but also to students of religions. Its appearance in an English edition is to be welcomed.

Kenneth Walker

AFRICAN CULTURES

Continuity and Change in African Cultures

Edited by William R. Bascon and Melville J. Herskovits. Pp. vii+309. (Chicago: University of Chicago Press; London: Cambridge University Press, 1959.) 52*s*. 6*d*. net.

THIS is one of the better collections of essays on Africa that have appeared in recent years. The introductory essay by the editors is an excellent summary of the problem, directing attention to some of the basic approaches to the subject which are too often lost sight of in the hurry of modern research. Four essays deal with "Africa as a Linguistic Area" (Greenberg), "African Art" (Cordwell), "African Music" (Merriam), and "The Factor of Polygyny in African Demography" (Dorjahn). The remaining nine are regional or tribal studies, two of them dealing with eastern Africa, one with the north-western Belgian Congo, and the rest with west Africa. Though there are three maps, illustrating language groups, culture groups, and music areas, it would have been helpful if a map had been included showing where the peoples studied are to be found.

Although the subject of the book is specifically "continuity and change in cultures", there is none the less a good deal of information about various aspects of the peoples represented; and unlike so much modern work on Africa, the book is mercifully free, to a great extent, from the jargon and involved writing that seems to be considered a necessary element in social anthropology to-day.

Of particular interest to historians should be the essay on "Ethno-History in the Study of Culture-Change in South-east Africa", which is an interesting, informative, and well-documented study, though it needs a map of its own; in fact each of the regional essays would have benefited by a map.

In his account of the Pakot (better written Pokoot), Prof. Schneider might have added the story of how Chaundy managed to persuade the people to use their stocks of cow-dung for fertilizer instead of keeping them merely as visible indicators of wealth, but gave up doing it when he had gone.

Although the book is intended as a study of various aspects of acculturation, it forms quite a useful introduction to the peoples with which it deals. The essay on "African Art" is a comprehensive survey of art throughout the continent, concentrating mainly, as is to be expected, on West Africa; but there are short sections on Eastern and Southern Africa and the Congo, and on modern African art. The author notes that "there are few African cultures where the concept of 'art for art's sake' seems to have existed"; I wonder if this is really true. The essay which follows this, on African music, is equally comprehensive.

At a time when so many anthropological studies of Africa tend to be of the 'social anthropological' kind, it is good to come across a book like this which deals with facts, and allows the facts to retain their importance. Though some of the essays in the book are within the field of social anthropology, the importance of the facts on which they are based is not minimized. This book is altogether to be recommended to those who wish to know more about certain aspects of African cultures before the countries in which they are found become independent and possibly undergo change in a different direction.

G. W. B. Huntingford

SELF-REGULATION FOR CHILDREN

The Free Family

A Creative Experiment in Self-Regulation for Children. By Paul and Jean Ritter. Pp. 269+4 plates. (London: Victor Gollancz, Ltd., 1959.) 18*s*. net.

THE authors of this book were inspired by the teachings of Wilhelm Reich and the example to A. S. Neill to bring up their five daughters in accordance with the principle of 'self-regulation'. According to this principle, children should be left to work out for themselves how they shall behave; when and what they shall eat, when they shall sleep, when eliminate, and so on. Adult interference is kept to the minimum necessary for the children's safety, and to prevent them from becoming too much of a social nuisance. Their lives begin with the birth procedures advocated by Dr. Dick Read.

On their own evidence, the authors appear to have carried this principle into action as successfully as is possible in a society which advocates quite different principles of upbringing. But their success seems to have depended on their being highly cultured, reasonably well-to-do and enjoying a good deal of leisure; and, what was more important, on being intelligent and exceptionally well-balanced and loving, so that they were able to tolerate the discomfort and mess which the children's self-regulation entailed. Although 'tension' inevitably arose, they were willing to accept this and to acknowledge that they were the probable cause—in their own words "everybody is silly sometimes". Even then, it is clear that the children experienced considerable difficulty in adapting themselves to the society of children very differently brought up.

This book is not of course a scientific document. We need independent evidence as to whether the children did in fact emerge with the degree of spontaneity, poise and stability which their parents claim for them. To prove the authors' thesis, studies must be made of many more and different families employing self-regulation. Only then shall we know whether self-regulation can be practised successfully by more than the fortunate few. By all means let parents be stimulated to try these methods; but let them realize well in advance what they are setting out to do.

M. D. VERNON

MOTIVATION

Motivation

A Systematic Reinterpretation. By Prof. Dalbir Bindra. Pp. vii+361. (New York: The Ronald Press Company, 1959.) 5.50 dollars.

IT has been clear for at least a decade that our ideas on motivation have been muddled and unable to accommodate some of our data. One way or another the notion has persisted that organisms are inert machines made to behave by instincts, drives, libido, *élan vital*, etc. Many contemporary learning theorists and psychotherapists still hold to this kind of view. Dr. Bindra persuasively marshalls a great deal of research evidence in the hope that they can be brought to change their minds.

The alternative he has to offer translates many motivational concepts into terms of stimulus and habit. We do not have to ask why an organism is active because activity, or irritability, is the property of living matter in virtue of which it is recognized as living. There are biochemical problems here but not psychological ones. What we are concerned with are those aspects of activity which are, or seem to be, purposive.

Not so long ago 'purposive' was shut away in a cupboard with 'consciousness', 'philosophy', 'introspection' and similar skeletons. The biologists, with their comparative freedom from methodological anxieties, have helped to bring it back into use. We can be objective here even though we cannot measure. Purposive behaviour is appropriate, persistent and searching. At the mammalian level, Dr. Bindra claims, most of this behaviour is learned. He suggests two generalizations.

"1. Some degree of repeated or continued exposure to a situation is a necessary condition for the development of activities that are goal-directed with respect to some features of that situation.

"2. Behaviour becomes goal directed by virtue of the fact that certain movements or component responses (occurring in a matrix of general activity) that are accompanied by a given goal are selectively strengthened or reinforced . . .".

This does not sound revolutionary, but the shift of emphasis from the drive to the goal, which is not necessarily set up by a drive, liberates subsequent theorizing, and makes it possible to handle data which traditional learning theory is apt to ignore or explain away.

There is some circularity involved in the new definitions of 'goal' and 'reinforcement', but Dr. Bindra sticks as closely as he can to his evidence and points to experiments instead of verbalizing when he wants to make his meaning clear. Socrates might not have approved, but the method works well enough when we are only groping towards a few empirical formulations.

What does seem clear is that we learn to avoid painful objects. We learn to be hungry (that is, develop a food addiction), and so the old drives cease to be available to us when we try to explain learning.

Dr. Bindra has written a timely and important book. It can bear comparison with Hebb's "Organization of Behaviour" from which it stems. The mixture of theoretical boldness and empirical bias which characterizes work in the McGill Department seems to be what is needed at our present stage in psychology.

J. DREVER

MEMORY AND LEARNING: A NEUROLOGIST'S POINT OF VIEW

Brain—Memory—Learning

A Neurologist's View. By Dr. W. Ritchie Russell. Pp. xii+140. (Oxford: Clarendon Press; London: Oxford University Press, 1959.) 18*s*. net.

THIS book gives the views of a well-known neurologist on the physical basis of memory and learning, to the better understanding of which he applies his extensive and critical appreciation of the effect of brain injuries, on which he is the leading medical (as opposed to surgical) authority in Great Britain. The theme is important and fascinating, for ever since the dawn of history man as a sentient being has pondered the secrets of his mastery of this mysterious universe in which we live. This further approach to our understanding of the brain as the bodily organ of mind is presented with considerable ease and felicity of expression.

Mental processes—themselves dependent upon brain cell activity—are considered in the light of recent neuro-physiological knowledge, which is also applied to a study of their impairment following concussion and focal traumatic lesions of the brain; the result is an enrichment of our understanding of the cerebral mechanism whereby man's dominant position in the universe has been achieved.

The book opens with a survey of some aspects of neuronal physiology, indicating that human thought and reason depend, not on the presence within the nervous system of any special features of the nerve cells themselves, but on the vastness of their numbers and on the utter complexity of their inter-connexions

through synaptic knobs on their surfaces and special spikes on their dendrites, whereby potential synaptic activity must be increased to an incredible extent. Much cerebral activity is concerned with the analysis of afferent stimuli in relation to previous experiences composed of memories and their emotional associations. This development of memory and the recognition of the familiar is believed to be effected through a process of neuronal facilitation with the ultimate result that what has been done once can more easily be done again. Intelligence presumably depends upon the capacity of the mind to associate together, rapidly and effectively, vast numbers of such memories, and this can only be if the brain is in a state of what amounts to almost ceaseless neuronic activity. Attention, memory, habit-formation, learning and intelligence all have their emotional aspects which are supremely powerful during early life, and it is the successful control, refinement and integration of these qualities that make possible the subsequent development of the balanced adult personality with perhaps unforseeable possibilities for the future. Considerations of speech and of such pathological states as epilepsy, pain and phantom limb sensations all yield additional information concerning the sensory-motor aspects of the brain–mind relationship.

This stimulating, provocative and at times speculative book is eminently readable and warmly to be recommended, especially for the wisdom of its concluding chapters. Gilbert Hall

60 YEARS OF LEARNING THEORY

Theories of Learning

By Prof. Ernest R. Hilgard. Second edition. Pp. ix+563. (London: Methuen and Co., Ltd., 1959.) 45*s*. net.

THE first edition of this book appeared in 1948. In the intervening years, a considerable amount of experimental and theoretical effort has been devoted by American psychologists to the study of learning with, so it seems, no very radical advances being achieved. The work begins with E. L. Thorndike and proceeds by way of chapters on the major stimulus-response theorists, notably Skinner and Hull, and on the other group of theorists which the author designates the cognitive. The latter include those making use of gestalt conceptions with their implication of an emergence of qualitative differences in learning and problem-solving, as between lower and higher organisms, rather than a quantifiable dimension from simple to complex. These tend to infer more freely the existence of central brain (ideational) processes in accounting for observed behaviour modifications, whereas the former tend to explain in terms of peripheral intermediaries such behaviour as the goal-directed sequence of a rat running through a maze to a distant food-box.

The author makes clear that these two groups of theories each include a diversity of points of view around the central distinguishing characteristic of peripheral or central explanations. He points out that probably the major issue, which cuts across both groups, is that of the role of reinforcement and drive in learning. Some writers have supposed that, in the first instance, learning may occur simply through associative contiguity, the achieving of a reward or the avoiding of a punishment serving merely to facilitate the occurrence of the learned behaviour on subsequent occasions. Others have maintained that learning does not occur at all unless some kind of reinforcement is available to the organisms in the learning situation. The crux of the matter between these two points of view lies perhaps in the kind of definition given to the term 'reinforcement'. It need not consist merely in obtaining a primary goal, such as food or avoidance of electric shock, or secondary (acquired) goals such as counters or verbal praise or punishment. It may also derive from the reduction of tensions set going, for example, by the animal's propensity to explore its environment. The discussion of these problems, together with other current developments, including the role of mathematical models in the construction of learning theories, is contained in three new chapters which constitute an important addition to the first text.

Changes and additions to the historical core of the text are to be found in the chapter on Hull, where his later postulate system is assessed, in the discarding of the chapter on Wheeler's organismic psychology, and in the inclusion of a new chapter of 38 pages on Freud's psychodynamics. Wheeler's omission represents a loss of little significance, but it is not clear that Freud's irruption into a historical text dealing with theories derived almost entirely from experimental data constitutes a substantial gain. The author says: "If there is any teaching which has come from Freudian psychology it is that motives are organized in some sort of hierarchy within the individual, resulting in a value-system expressed in behaviour" (p. 348). But the key to this inclusion seems to be the awareness that motivation, whether in its conditioned or its instinctive form, is very inadequately dealt with by most learning theorists.

In considering the organisms from which learning data and theory are derived, it is common knowledge that the animal favoured by psychologists has been the rat. Index references confirm the rat's priority over all other laboratory animals in the ratio of about 2 to 1. References to human learning make up a poor second to the rat. Allowing for the experimental conveniences of rats as learning-apparatuses, this still must constitute a severe restriction upon the general and comparative significance of the learning theories discussed. Indeed, it would seem justifiable to describe most stimulus–response theories as rat-derived, most cognitive theories as primate-oriented. This is a defect, not in the author's scope, but in the range of the work which he is very ably sampling. A vital corrective to this species-restriction is necessary, and much may be learned by learning theorists from the experimental–ethological studies of Thorpe, Tinbergen, and others.

We are left with the view that there may turn out to be several different types of learning which, at the present stage of theory construction and experimental evidence, cannot be resolved by single theory treatment, even of the promising mathematical model variety. But, although our reading of this book should lead to a critical dissatisfaction both with the theories and with the supporting evidence, the author has, in general, produced an invaluable historical survey and appreciation of current trends which merits the careful study of every student of behaviour.

K. R. L. Hall

SOCIAL SCIENCE, CRIMINOLOGY AND PSYCHIATRY

Social Science and Social Pathology

By Barbara Wootton, assisted by Vera G. Seal and Rosalind Chambers. Pp. 400. (London: George Allen and Unwin, Ltd., 1959.) 35*s*. net.

THE discrepancy between the brilliant achievements of the natural sciences and the slow progress of social science is one of the most disturbing features of our civilization. Recently there has been a good deal of stocktaking among social scientists. What is the scope of this field of study and what are its methods of research? Is there only one social science or are there several social sciences? What ought to be the relationship of social science to the two fields of study most closely concerned with human behaviour, that is to say, psychology and psychiatry? Lady Wootton tries to answer some of these questions in this book written in anger and without pretence of scientific detachment. It is addressed to the interested lay person.

The work falls into three parts. The first presents a critical survey of contemporary research into the origins of crime. Twelve hypotheses are listed and found wanting. Theories about the role of the broken home and the lasting effects of maternal separation or deprivation on behaviour come in for special criticism. Many of the strictures are justified, but none of them is new. Lady Wootton believes that criminological research has achieved very little and that progress is unlikely unless social science rids itself of evil influences. She regards the rise of psychiatry as its greatest danger. Her book can be viewed as a desperate attempt to halt this threat.

Lady Wootton detests imprecision and uncertainty. She insists on clear boundaries, especially between the bad and the mad. Unfortunately, such boundaries do not exist in Nature. She blames the psychiatrists for the existing confusion. In Part 2, which is entitled "The Contemporary Attitude to Social Pathology: the Social Implications of Psychiatry", Lady Wootton sets out to show psychiatrists up for what she thinks they are, namely, unscientific, ignorant and power-hungry empire builders. She deplores the intrusion of psychiatric concepts into social science. She has nothing good to say about psychiatry, except that it has had a humanizing influence. She takes a great deal of trouble to show that the concepts of mental health and mental hygiene are ill-defined and influenced by ethical premises and value judgments. She is particularly severe on the notion of adjustment.

All this amounts to the statement that there is no clear boundary between mental health and mental illness. Lady Wootton presents this as if it was a discovery which ought to disqualify psychiatry from having a say in the study of antisocial behaviour. The reader is led to believe that those uncertainties are specific to mental health and illness. In fact, they also exist in physical health, which is a concept equally elusive of definition and no less 'value-soaked' than mental health.

The intelligent reader will take heart from the knowledge that medicine has not done too badly even without such a definition. Nor has the scope of physical medicine remained static. Many conditions which are now treated by the physician were not so long ago outside the scope of medicine. Lady Wootton has a simple explanation for the widening of the scope of psychiatry. Moral problems have been incorporated into medicine "for no other reason than that doctors have decided to enlarge their empires so as to include territory formerly regarded as belonging to morality rather than to medicine, and so as to make a place for psychiatry in the medical curriculum". This statement shows a lack of historical insight which is most disturbing in one so eminent. Lady Wootton has not taken the trouble to find out why psychiatry is no longer confined to the 'insanities' but has become the study of abnormal behaviour. If she had given some time and thought to this problem, she would have learned that this change of the scope of psychiatry was due not only to psycho-analysis but also to the discoveries of the effects of brain lesions on behaviour.

Lady Wootton is alarmed about the vagueness of the concepts of psychopathy and mental deficiency. It is, of course, true that moral and medical judgments often overlap and are difficult to disentangle. There are still very few objective criteria of mental illness, and often the first and only indication of its presence is social failure. A considerable time may elapse in an individual case before other signs of illness can be demonstrated. All this is rather confusing, and sometimes the doctor, by introducing his own uncertainties, makes it difficult to administer the law; but this is an inevitable complication where knowledge is incomplete.

Lady Wootton is ultra-conservative concerning the safeguards against conviction for offences committed in a state of mental disorder. She does not think that the McNaghten rules, which reflect the medical knowledge of 1843, can be improved upon and she is opposed to the concept of diminished responsibility. She resents the 'privileged' position of the medical profession. It is a pity that Lady Wootton has not heeded her own warning that "in social research generally, constant vigilance is necessary against the risks of prejudice". Her attitude against the medical profession has a Shavian flavour, without being entertaining.

Lady Wootton condemns the emphasis on personal relationship in social work. The social worker ought to concern himself only with economic and not with personal difficulties, which, she believes, can be kept apart. The chapters dealing with the role of the social worker appear the most unenlightened of the whole book, probably because here the author speaks as an expert.

The concluding chapters make gloomy reading. Lady Wootton re-states her poor opinion of social pathology in its present immature state. Like everybody else, she wants more facts and more sophistication in the formulation of hypotheses. She believes that for some time to come the destruction of myths is going to be the chief pre-occupation of the social scientist.

It has been said that the main characteristic of the scientific attitude is the scientist's devotion to the detection of his own errors. Scientists must also undertake the task of proving others wrong. Lady Wootton has dedicated herself to the latter, but in doing so she has neglected the former, which is the true test of the scientific outlook. This is why this book gives a distorted picture of the state of social pathology.

E. STENGEL

A DIVERSITY OF TRENDS IN MEDICINE

Ciba Foundation Symposium on Significant Trends in Medical Research

Edited by G. E. W. Wolstenholme, Cecilia O'Connor and Maeve O'Connor. (Tenth Anniversary Symposium.) Pp. xii+356. (London : J. and A. Churchill, Ltd., 1959.) 50*s*. net.

THIS account of the transactions of a special symposium arranged in June, 1959, to celebrate the tenth anniversary of the Ciba Foundation is the fiftieth major volume published for the Foundation. The aim in selecting the thirteen original papers, here printed together with the discussions on them, was to pick out the advances in medical research in the past ten-year period which would prove to be most significant in the next ten years. The speakers fortunately eschewed prophecy and talked about the work they were interested in personally. Distinguished as the participants were—they included seven Nobel laureates—it seems doubtful if any of them could have taken a sustained interest in everything that went on, or understood the whole of a terminology which included nuclear-spin and electron-spin magnetic resonance, genome, the ascending reticular system and co-arctation of the aorta. Few active scientists to-day are polymaths, and trends in medical research may diverge too widely to be the focus of a single gathering.

The Ciba Foundation has done such admirable work in providing hospitality for visiting scientists and arranging symposia of groups of experts that one must not grumble at an occasional *Festschrift* or express a perhaps purely personal prejudice against studying so many topics at once. Some of the subjects dealt with were general neurophysiology, hormones, pancreas and insulin, chronic pulmonary disease, clinical nutrition, and the organization of research in the United States. The remaining papers, which are concerned with such subjects as molecular structure in relation to biology and medicine, enzymes, the chemical basis of virus multiplication, population dynamics of body cells, genetics and medicine, malignant transformation, and the quantitative approach to disease as exemplified by essential hypertension, are a more homogeneous collection. They have in common the transmission of cellular characteristics, the disturbances which avoidably or unavoidably occur in this process, and the manifestations which these produce in the organism as a whole. The subject interests a wide range of workers, from electron microscopists to population research workers, and it will undoubtedly form a major trend in medical research in the next decade.

Pauling, Burnet and Medawar briefly indicated their own important contributions, discussing in particular the mechanism of antibody formation, and the question whether the relationship between stimulus and response should be described as 'instructive' or 'evocative'. Similar ideas were shown to underlie our notions of embryonic differentiation, ageing, and malignant disease. Waldenström (his Figs. 2 and 3 have unfortunately been transposed) emphasized the need for greater precision in the description and interpretation of inherited disease in man if human genetics is to support its theoretical superstructure, and Pickering reviewed his work on the incidence of hypertension and the quantitative approach to disease. Not all his audience agreed that the ability to arrange the blood pressures of a population in a normal frequency distribution curve tells us much about the etiology of essential hypertension. Moreover, it is doubtful whether many scientific clinicians to-day believe, as he suggests they do, that "a patient with a specific disease has a single basic fault". Indeed, I think the majority will be rather encouraged to learn that Waddington thinks the one-gene, one-enzyme hypothesis is an abstraction.

The book has been produced with remarkable speed, considering the inclusion of the discussions and the intervention of the printing strike, and it is a testimony to the experience and skill of the editors in this field.

L. J. Witts

THE EYE AND VISION

The Eye in Evolution

By Sir Stewart Duke-Elder. (System of Ophthalmology, Vol. 1.) Pp. xvi+843 (902 figures)+15 plates. (London : Henry Kimpton, 1958.) 126*s*. net.

Documenta Ophthalmologica

Advances in Ophthalmology, Vol. 13. Edited by G. von Bahr, G. B. Bietti, J. ten Doesschate, H. Fischer-von Bünau, J. Francois, H. Goldmann, H. K. Müller, Jean Nordmann, A. J. Schaeffer and Arnold Sorsby. Pp. xii+516. (The Hague : Dr. W. Junk, 1959.) 75 guilders.

BOTH these books are directed towards ophthalmologists. One is written by a clinician, the other records the work and opinions of men many of whom are clinical ophthalmologists. It is significant that the material is largely made up of the basic sciences upon which ophthalmology is built.

Sir Stewart Duke-Elder explains why he has preferred to initiate the preparation of a "System of Ophthalmology", of which he will be editor, to the production of a second edition of his own comprehensive, internationally renowned and sought-after "Text Book of Ophthalmology". Much of the material in its seven volumes is now out of date and the earlier volumes out of print. But while this new book, written by Duke-Elder himself, is the first of fifteen planned volumes to cover ophthalmology it is an entity in itself which can be read and entirely enjoyed not only by clinicians but also by anyone interested in natural history, and in man. Its pattern is perhaps best shown by extracts from the epilogue and introduction in that order.

"This is the story of the development of the eye from the primitive undifferentiated protoplasm of the simplest protozoon to become the most highly efficient sensory mechanism in the animal kingdom in the eyes of Birds. It is the story of the development of the sense of vision from an autonomic response associated at some stage with a vague awareness, to the capacity to be enraptured by a rainbow or to create a thing of beauty".

"It is a fascinating story extending back to where life started, a story mostly of steady progress, now in this direction, now in that, as one expedient after another was tried, this one to be discarded, that to be perfected".

"We begin with a drop of viscid protoplasm the reactions of which we do not understand and we end

lost in the delicacy of the structure of the eye and the intricacies of the ten thousand million cells of the human brain".

"If, indeed, the proper study of mankind is Man, and if (as we must agree) his behaviour and his contact with the outside world are mediated through his senses, what can be more fundamental than the study of the sense which, more than any other, determines his intelligence and regulates his conduct . . . ?"

To tell this story of the evolution of the eye and of vision through the animal world a vast amount of learning has been sought, assembled and arranged. It is presented in the same delightfully readable way that characterized the "Text Book of Ophthalmology". Not only is the reading easy, it seems easy to absorb the facts, and the lightness and grace of the writing tend to eliminate any text-book impression.

It is profusely and beautifully illustrated, and attractive marginal line drawings of many creatures have been added to supplement and enliven the text. The pleasant practice of opening a chapter with the photograph of, and notes about, an authority in the subject of that particular section has been carried on from the "Text Book". The layout and the production of this volume are excellent and clinicians at least will look forward eagerly to those which are planned to follow it.

Most of volume 13 of "Documenta Ophthalmologica" is given to the papers and discussion at a symposium on glaucoma held in Liège by invited participants from Europe and the United States. The papers are in English, French and German, and some of the mathematics and hydrodynamics will be beyond the ordinary ophthalmologist. But the reported work and the discussions which followed each paper provide a most interesting and instructive review of the research, basic and clinical, which in many centres is focused on aspects of the physiology and anatomy of the eye and the earliest evidences of an insidious disorder which accounts for much blindness, and which may well have its start earlier in life than has been generally thought. The last paper is an interesting, if abstruse, review of published ideas on frontal reference surfaces of binocular visual space commonly referred to as horopters.

R. C. DAVENPORT

EARLY ETHOLOGY

Instinctive Behaviour

The Development of a Modern Concept. Translated and edited by Claire H. Schiller. Contributors: D. J. Kuenen, Konrad Lorenz, Nicholas Tinbergen, Paul H. Schiller, and Jakob von Uexkull. Pp. xix + 328. (London: Methuen and Co., Ltd., 1959.) 45*s*. net.

DURING the past twenty-five years very considerable progress has been made in the study of instinctive behaviour. This has been due largely to the work of Konrad Lorenz in Germany and Niko Tinbergen in Holland and England. They in turn owe some of their inspiration to a small number of earlier workers—Heinroth and von Uexkull, Whitman and Craig, J. Huxley and Eliot Howard. Their work has resulted in the development of ethology—a discipline characterized not by any strict boundaries to its subject-matter (indeed most ethologists are busy attempting to establish bridgeheads with related fields such as physiology, psychology, ecology and genetics), or by a formal theory, but rather by the orienting attitudes of its research workers. These attitudes reveal the influence of a zoological background, and include an interest in problems of the function and evolution of behaviour as well as its causation, an emphasis on the importance of the description and classification of behaviour as a preliminary to analysis, and an interest in comparative studies.

"Instinctive Behaviour" is a collection of some of the earlier ethological papers, translated into English by Claire H. Schiller. As such, it is not to be taken as representative of modern ethological views, but rather as showing the sources from which they developed. The first essay, first published by von Uexkull in 1934, is concerned with the relation between an animal's perception of its environment and its sensory capacities. This relationship is obvious enough now, but needed emphasizing at the time: the paper contains a number of interesting observations, as well as some rather far-fetched speculations.

The greater part of the book consists of six essays by Lorenz, Tinbergen and Kuenen, alone or in combination, including Lorenz's (1935) "Kumpan" paper and the classic papers on the egg-rolling of the greylag goose and the begging of young thrushes. The extent of Lorenz's and Tinbergen's genius is shown by the fact that many of the ideas which have proved useful in ethology were fully developed in these essays written twenty years ago. The use of fixed action patterns in comparative study, the evolution and function of social releasers, the nature of animal language, the integration of discrete actions into functional sequences of behaviour, and many other topics are discussed here in detail; and later workers on such subjects have had to do little more than fill in the details. At the same time, these papers contain much of the earlier theoretical background to ethology which is now discarded by most ethologists as well as by Lorenz and Tinbergen themselves. Lorenz's discussions of the innate/learning controversy, releasing mechanisms or the precise nature of 'action-specific energy' make curious reading now; though in their day they were fertile in provoking observation and experiment.

The last essay, by Lorenz, in this book (1952) contains a summary of Tinbergen's hierarchical scheme of nervous centres. This model embodied many of the earlier ethological ideas, and will probably come to mark the end of a phase in ethological thinking. Since then Lorenz and Tinbergen have developed new approaches and produced fresh ideas; but these are not represented in this book. In their later writings the distinction between the valuable general principles on which ethological work is based on one hand, and its earlier rather loose theoretical concepts on the other, becomes apparent.

This volume was planned and begun by the late Paul H. Schiller. It contains one previously unpublished essay by him on the importance of 'innate' organization in determining the course of learning in chimpanzees, in which he emphasizes that a knowledge of this organization is essential for analysing the acquisition of skills. This paper provides an example of the way in which ethology must develop—by inter-action with other fields of study in which ethological observations and methods can be applied.

R. A. HINDE

A NINETEENTH-CENTURY BOTANIST

Asa Gray, 1810–1888

By Prof. A. Hunter Dupree. Pp. x+505+9 plates. (Cambridge, Mass.: The Belknap Press of Harvard University Press; London: Oxford University Press, 1959.) 60*s*. net.

THE story of Asa Gray is told against a background of history concerned with the intellectual development of America during the nineteenth century. These pages should appeal not only to botanists, who know of its subject as one of the pioneers in the study of the geographical distribution of the American flora, but also to all those interested in the growth of the fruitful scientific collaboration between the New World and the Old in which Asa Gray played a notable part.

Born in 1810 of farming stock, Asa Gray was reared in the beautiful valley of Sanquoit and worked in the bark mill of his father's tannery. He was eighteen when plants caught up his interest, and he began to make a herbarium during his apprenticeship, for like so many of the earlier botanists he was educated as a medical practitioner. At the age of twenty-eight he was appointed professor of botany to the new University of Michigan and was enabled to visit Europe, which gave him the opportunity of forming the contacts with William and Joseph Hooker, George Bentham, Lyell and Charles Darwin that were to have a profound influence upon his subsequent career as an investigator.

While the author of this work emphasizes how Gray's scientific activities were chained to the results of American expansion and exploration, these nevertheless provided both the opportunities and the means. It was Asa Gray's good fortune to discover in the eastern States single representatives of Japanese genera previously regarded as monotypic, thus confirming his conclusions that while the European connexions are most marked on the side of the American continent nearer Europe, those with Asia are greatest on the remote side. It was these observations and his wide grasp of the North American floristics which attracted the attention of the Hookers and later of Darwin when he turned his attention to the botanical field.

From these pages we get the impression of their subject as a vigorous character, but quite incapable of estimating what he could, in fact, accomplish so that during his more active period 'the incomplete works of Asa Gray' continued to augment. It is an interesting sidelight on his personality that antagonism to the views of Agassiz would seem to have been an important stimulus, just as it was Alphonso Woods publications that appear to have provided the requisite catalyst for Gray to write his "Manual", that was his most important work, and which might otherwise never have been completed.

The Gray Herbarium was a vast collection that bore tribute to his drive; and the difficulties he had with the collectors, upon whom he relied for the new plants he described, are well portrayed as well as the impediments that these pioneer workers had to overcome in the tasks of identification.

The author of a biography may be forgiven a partiality for his subject and to such bias we may perhaps attribute the statement that Gray "shewed the qualities of mind and character necessary to rise to Darwin's level". But even though the reader may scruple to accept this assessment he cannot but be grateful to the author for this fully documented presentation of the man and his environment.

E. J. Salisbury

MASTER OF MICROBIOLOGY

Albert Jan Kluyver

His Life and Work: Biographical Memoranda, Selected Papers, Bibliography and Addenda. Edited by A. F. Kamp, J. W. M. La Rivière and W. Verhoeven. Pp. xv+567. (Amsterdam: North-Holland Publishing Co.: New York: Interscience Publishers, Inc., 1959.) 80*s*.

THIS book contains a record of the life and work of a great microbiologist—perhaps the last we shall see of those encyclopædic men whose field was the study of micro-organisms as a whole. Micro-organisms have an increasing role in human activities: as agents of soil fertility and in the production of prophylactic, therapeutic and other economically important materials, and as agents in animal and plant diseases and in the spoilage of stored products. The utilization and control of micro-organisms will be increasingly important as populations grow, with their increasing demand for food and for the prevention of disease. Applied physics may steal the headlines for a while, but when all is said, the problems of food production and of health will remain, and in these micro-organisms must play an important part. The concepts of the 'unity of biochemistry' and of 'comparative biochemistry' which Kluyver enunciated so clearly are cardinal in modern biological studies. Micro-organisms multiply quickly and we now know that it is often possible by studying them to gain information of general biological importance more easily and rapidly than by studying more complex organisms. Kluyver's work in microbiology is an example *par excellence* of that interweaving of biochemistry and biology which is now proving so fruitful in biological studies. The line of Dutch microbiologists such as Leeuwenhoek, Beijerinck and Kluyver forms one of the great arteries of microbiology; this school has been particularly concerned with fundamental studies of microbial physiology. Another equally important line comes, of course, from the Pasteur school, which developed particularly the study of disease-producing organisms and the prevention of their effects. Both lines of development lead, in the end, to study of the biochemistry of the modes of action of specific micro-organisms. An important feature of the work of the Dutch school has always been the study of micro-organisms in general, of what they do and how they do it: general microbial physiology.

The book is divided into three parts; most of it is in English.

Part 1. Biographical memoranda. This begins (pp. 3–67; illustrated by 23 photographs) by giving the outline of Kluyver's life, with a very interesting section about Kluyver as seen by his pupils. There follows (pp. 68–155) a masterly survey by C. B. van Niel of Kluyver's contribution to microbiology and biochemistry. This part closes with two moving funeral orations.

Part 2. Selected papers (pp. 165–524). The papers selected are, with two exceptions, those of which Kluyver was the sole author. They are mainly the

general articles and lectures in which he displayed his masterly grasp of, and wide-ranging thinking about, microbial physiology, and are written in his characteristically vivid personal style. In these writings Kluyver established himself as a great thinker and teacher about microbiology: the experimenter who related his findings to the advance of his field of science as a whole. Every one of these papers should be read and digested by anyone who is concerned with the future trends of microbiological science and its mode of progress.

Part 3. Bibliography and addenda (pp. 527–563). This contains detailed lists of joint papers by Kluyver and co-workers, of doctoral theses supervised by him, of papers from the laboratories at Delft and Utrecht which he influenced; lists also of the members of the staff at Delft during Kluyver's directorship, of the many honours conferred upon him, and of obituary articles. This simple documentation of his work and influence strikingly illustrates his energy and breadth of interests.

Kluyver was a splendid man and a splendid scientist of the kind most fitted to this epoch. He was never content only to deepen his studies of microorganisms, but was always conscious of, and able to explain clearly, the relations of the work of his school to the advance of microbiology as a whole. His work and influence continue to shape that science. What better memorial could a man wish than that people will return again and again to his writings to seek refreshment and inspiration. This beautiful volume should be possessed by every university library and every department of biological science.

B. C. J. G. KNIGHT

DIAGNOSIS OF HUMAN GROWTH

Growth Diagnosis

Selected Methods for Interpreting and Predicting Physical Development from One Year to Maturity. By Leona M. Bayer and Nancy Bayley. Pp. xiv+241. (Chicago: University of Chicago Press; London: Cambridge University Press, 1959.) 10 dollars; 80*s*. net.

PHYSICIANS concerned with the treatment of children and adolescents will be glad to see a book which provides them with a set of blue-prints for assessing growth. In a number of research centres, and particularly in the United States, the individual progress of hundreds of boys and girls has been documented from birth to maturity. Based on these studies, the details of growth have been precisely delineated to show increases in individual parameters and changes in proportions as well as in certain more superficial and subtle aspects of body covering and contour.

Since deviations in growth pattern may reflect corresponding physiological abnormalities, accurate recognition of deviations can be an important diagnostic aid. An exact description of the morphological and temporal aspects of a growth deviation may thus provide a reliable guide to its probable ætiology.

Before establishing deviations, however, it is necessary to define norms, and this the authors do by selecting examples from a population which is ethnically homogeneous, clearly described and numerically adequate; the norms can also be statistically defined. These anthropometric norms have been derived mainly from American children of European origin who have been nurtured under favourable conditions; in most cases they have been expressed in means and standard deviations.

The great value of this book is that it is very practical. Elaborations of anthropometric measures and indices are limited to five each, and have been chosen for their simplicity and for their usefulness over the whole span of childhood and adolescence and for their special relevance to sexual differentiations. Most physicians wishing to make use of the extensive lists of charts and tables should be prepared to take three measurements in addition to the conventional heights and weights.

Although a different presentation might have been required, it is unfortunate that Prof. Bayer and Dr. Bayley have not rounded off such an eminently useful work by the inclusion of relevant information for babies up to the age of one. This is the age-group which commands greatest interest and which could act as a starting point whereby British physicians might take a greater interest in the subject of growth diagnosis.

This book would be appreciated by members of school medical services, maternity and child welfare officers, general practitioners, Service and industrial medical officers, and all students of human biology who are interested in promoting the positive health of children and teenagers. K. M. HAWKINS

RED, ROE AND FALLOW

Wild Deer

By A. J. de Nahlik. Pp. 240+26 plates. (London: Faber and Faber, Ltd., 1959.) 70*s*. net.

IN the past five or six years there has been a great increase in interest in the wild deer of Britain, both by naturalists and by sportsmen. The Deer Group of the Mammal Society of the British Isles focuses the naturalists' interest and the St. Hubert Club the sporting interest. Squadron-Leader de Nahlik is a member of both, and his book links the two interests, but leaning rather on the sporting side.

He confines himself to three species out of the five or six that are at present running wild in British woods, namely, the native red and roe deer and the probably introduced fallow. The three aliens which he ignores are the widespread sika, the locally common (in the Midlands) muntjac or barking deer, and the much more local Chinese water deer. The book is the fruit of many years field experience of deer, both in Britain and on the Continent, and no doubt the reason that the sika and muntjac are omitted is because the author has not wished to write about animals of which he has no personal experience.

Into the natural history of the red, roe and fallow the author goes reasonably fully, dealing especially with their annual breeding cycle, antlers and how to recognize them at various stages of their development. He tackles next the problem of damage by deer to farming and forestry, and the various methods of control, including the use of chemical repellents. These last have been much more fully investigated on the Continent than in Britain, and it is most useful to have a full list of them, their uses and manufacturers, for the first time in any book on British deer. Other chapters discuss the various niceties of deer shooting and stalking, and so are of less interest to the natural-

ist, except in so far as the management of a deer forest needs to be done scientifically. However, even naturalists enjoy venison, so the appendix of various ways of cooking this delicacy will doubtless have a wide appeal. There is also a valuable glossary at the end, in which not only are such technical terms as 'beam', 'gralloch', 'tine' and 'trey' explained, but also their equivalents are given in five European languages: German, French, Spanish, Italian and Polish. The book is well illustrated with black-and-white photographs and there are some thirty diagrams in the text.

R. S. R. Fitter

THE ARADIDAE

Classification of the Aradidae (*Hemiptera-Heteroptera*)

By Robert L. Usinger and Ryuichi Matsuda. Pp. vii+410. (London: British Museum (Natural History), 1959.) 80*s*.

THE Aradidae are a small family of mycetophilous bugs mostly occurring on or in wood of forest trees. Before the appearance of this book they comprised some 64 genera and 685 species, and had not been comprehensively studied since the time of Stål. As Prof. Usinger points out, accident and mischance held back taxonomic advances in this group; but the dispositions made in the present work result so extensively from the study of new material that it would seem unlikely that they would have been anticipated had earlier work been completed on the basis of existing collections.

The arrangement is logical and the presentation easy to comprehend. At the beginning, 28 pages, illustrated with 20 figures and two plates, are devoted to morphology, and facilitate interpretation of the descriptive text. This section is furnished with a separate bibliography. Seven pages are devoted to the biology of Aradidae, and as most of these are occupied by a long table of plant associates, it is evident that almost everything has yet to be learned about the preferences of species for their fungal substrates. Nevertheless this section is tersely written, and conveys a substantial amount of information. Geographical distribution is treated in the eight pages which follow, in which a tabular synopsis of generic distribution between seven zoogeographical areas is followed by a discussion of salient points. The reader will find it necessary to seek amplification of the data in the descriptive part of the text, especially with regard to the genera pigeon-holed in the 'Neotropical' column.

The classification itself occupies 326 pages, and (to quote Prof. Usinger) "is, in effect, a generic classification . . . with new species described only when necessary to validate new generic names or when desirable to elucidate little-known groups". The new matter comprises two subfamilies, fifty-nine genera and about eighty-two species, and almost doubles the number of genera hitherto known, and increases the number of species by nearly 12 per cent.

In Aradidae, as elsewhere, it is not easy to recognize close relationship through common ancestry as opposed to parallel evolution, and the authors have judiciously used zoogeographical data as a criterion of natural relationship. This serves to throw into prominence the anomalous cases which remain, such as the distribution of species of *Ctenoneurus* (Australasia and West Africa). Lists of species are provided after each genus, and sometimes keys, but "only where they are up-to-date or complete on the basis of work done by the senior author in European Museums in 1948–49". The descriptions are uniform and exhaustive; but the bizarre contours of an aradid give especial point to the dictum that a drawing, however crude, is better than a torrent of the most carefully selected adjectives, and the authors have percipiently illuminated the text with superb line illustrations. In large part their inclusion was made possible by a grant from the Trustees of the British Museum, and readers will applaud their action. The book is completed with a bibliography of eighteen pages and an index to all taxonomic categories in the family.

R. G. Fennah

PARASITES, IMAGINARY AND REAL

Parasites and Parasitic Infections in Early Medicine and Science

By Prof. R. Hoeppli. Pp. xiv+526+23 plates. (Singapore: University of Malaya Press; London: Oxford University Press, 1959.) 25 Malayan dollars; 63*s*. net.

REINHARD HOEPPLI is known to parasitologists as the author of many papers on helminthic and other parasites and various aspects of parasitism. His work during the past forty years has been concerned with experimental parasitology and pathology as well as morphology and taxonomy, but sometimes he has written, with or without collaborators, on ancient knowledge in this field. Such papers on the history of his subject have appeared more often during the past ten years and they seem to have formed the basis of this meticulous book, which is divided unequally into three parts.

Part 1 (11 chapters and 269 pages) deals with the earliest period up to the middle of the seventeenth century, covering such topics as the knowledge of parasites, clinical symptoms, imaginary and false parasites, the doctrine of spontaneous generation, therapeutic and cosmetic uses to which parasites have been put and the treatment and prevention of infection.

Part 2 (12 chapters and 198 pages) concerns special parasitological subjects of historical interest such as malaria, dysentery, leeches and scabies in Chinese medicine, some early views shared by the people of Borneo, Malaya and China, and ancient opinions held by the indigenous populations of Fiji and Tahiti. One chapter discusses exchange of ideas concerning infections, and it may well indicate some of the ways in which parasites themselves were spread.

Part 3 is a very short outline of 16 pages concerned with the increase in knowledge of parasites from the middle of the seventeenth century to the middle of the nineteenth, and this contains so many names of parasites and persons that other readers may also wish that the author had amplified this portion of his text. The book ends with a short conclusion, an appendix of 8 pages on the role of parasitic diseases in history, a subject index, an index of names, and 23 plates illustrating ancient conceptions of parasites, imaginary parasites, magic treatment and various kinds of indigenous medical treatment in Sarawak.

The author's aim has been "to give a picture of early parasitology by showing the actual knowledge of parasites and parasitic infections of the time together with prevailing ideas, common beliefs and errors formerly connected with parasites".

The book is largely anecdotal and discursive, and the author has given many quotations from early Chinese, Greek, Roman, Italian, French and German authors, together with translations of them. Much ancient lore about fears and superstitions, materia medica and whimsical forms of treatment is displayed, and it ranges from the horrific to the mildly amusing.

Imaginary parasites included the corpse worm, supposedly undergoing six transformations before finally appropriating the soul and leaving the patient's body to infect a close relative with the wasting disease phthisis. Another was the echoing worm, which produced an abdominal echo whenever the patient spoke. One patient read the herbal "Pen Ts'ao" as far as the description of Lan (indigo plant), when the echo subsided. He then took some juice of Lan and was sick, and the echo was heard no more! Another patient read on as far as thunder pills, took some of these, and likewise cured himself. Silence was essential during the preparation of the medicine, because the parasite would refuse to emerge should it hear any word about the drug to be used.

The reader is also reminded that pseudo-parasites flourished long after the compound microscope was pressed into service. For two centuries spermatozoa were regarded as Infusoria, and von Baer considered them to be a kind of cercaria. The doctrine of spontaneous generation is considered in its application to parasites and the possible origin of parasites as inborn entities is also reviewed. The Preformationist Vallisnieri believed that all future helminths, as well as all future human beings, were contained in the ovaries of Eve!

As reading proceeds, however, the impression lingers that this is not so much a book as a somewhat restricted and disjointed collection of papers. Indeed, 12 chapters of Parts 1 and 2 are based on previously published papers, although this is indicated only by footnotes. Some chapters are scarcely worthy of the name, because they are short topics which would scarcely be missed if deleted. Chapters 6, 7 and 8 in Part 1 and Chapter *G* in Part 2 are examples. The book contains much that is not strictly parasitological, for example, Chapter *K*, Part 2, which deals with the role of the Moon in biology and medicine. In only the short third section (3 pages of notes) are parasites mentioned, and the chapter ends with the conclusion that "no such (supposed) influence has ever been proved", reported cases falling down under "scientific criticism" or being "pure superstition".

Yet, Prof. Hoeppli's book deserves to be widely read by parasitologists, as no doubt it will be, though its theme fosters the view that there is something horrific about parasites, which work towards the discomfiture and often the destruction and death of their hosts. This may well be true of many of the parasites of man and domesticated animals, but it is an inaccurate conception of parasitism. The book does show that many errors of judgment have gone in procession down the ages, which may have a salutary effect on parasitologists who accept over-readily what has passed before as irrefutable truth. In such a way, this book may act as a spur to further research.

BEN DAWES

PROGRESS IN PLANT PATHOLOGY

Plant Pathology
Problems and Progress, 1908–1958. Edited by C. S. Holton, G. W. Fischer, R. W. Fulton, Helen Hart, and S. E. A. McCallan. Pp. xix+588. (Madison, Wisconsin: University of Wisconsin Press, 1959. Published for the American Phytopathological Society.) 8.50 dollars.

Plant Pathology
An Advanced Treatise. Edited by J. G. Horsfall and A. E. Dimond. Vol. 1: The Diseased Plant. Pp. xiv+674. (New York: Academic Press, Inc.; London: Academic Press, Inc. (London), Ltd., 1959.) 22 dollars.

IN design and purpose these two books are very different but each reflects the progress in plant pathology that has taken place during the present century, and each is the result of an international effort to present an accurate picture of the stage reached. One is the published record of the 1958 golden jubilee meeting of the American Phytopathological Society, which took the form of a series of seven major reviews and nine academic symposia chosen to cover all the important facets of plant pathology. The meeting and the book were carefully planned in advance, with the written part subject to certain manuscript specifications that controlled the form but not the content of the contributions. The other was designed to present an integrated synthesis of the parts of plant pathology for the advanced student. Its framework was constructed with enthusiasm by two distinguished editors with unconventional ideas, who have left their impress in greater or less degree on the content as well as on the form of the contributions. The jubilee volume is self-contained, and is essentially a record, if a selective one, of research carried out: the treatise, with a text about two-thirds the length of the other and decidedly more expensive, is only the first of three volumes which together are intended to provide a comprehensive theoretical treatment of plant pathology.

The first part of the jubilee volume is devoted to addresses given by Prof. E. C. Stakman and six other American plant pathologists of international standing. They review the status and role of plant pathology in the scientific and social development of the world, its growth in North America and the part played by the American Phytopathological Society, as well as certain landmarks in control of disease through host resistance and by the use of chemicals. The symposia, which make up the rest of the book, cover such diverse topics as the physiology of parasitism, the genetic mechanisms governing pathogenicity and disease resistance, soil fungi, the structure and multiplication of viruses, epidemiology, fungicides, and the concepts and problems of nematology. It is only meet and right that most of the contributions should issue from North America, but there are eleven from Britain, including five from Rothamsted, together with a few from Australia, South Africa, Germany and the Netherlands. The inclusion of a section on nematology in a work on plant pathology is no longer the surprise it was to the British plant pathologist, who is likely to find heavier going in the plant virus section, though once again F. C. Bawden displays his great skill in lucid presentation. The history of the American Phytopathological Society

and of its journal *Phytopathology* makes interesting reading. The Society, which began with a subscription of 50 cents and 130 charter members, is now nearly 2,000 strong. Its originator, C. L. Shear, was the first secretary-treasurer and L. R. Jones the first president. The book is very good value for money.

In the "Treatise" the diseased plant is the important object and the pathogen takes second place. Indeed, it is relegated to a second volume which will focus attention on the pathogen, on techniques inhibiting it, and on pathogenicity, while the third volume will cover the public health aspects of the subject, including disease epidemics and their control. In this first volume there are a few introductory chapters on the history of plant pathology, its relationship to other scientific disciplines, and losses caused by disease, but the text is largely devoted to the suffering plant, to pathological processes, defence mechanisms, predisposition and therapy. As the editors make clear in their prologue the main theme revolves round the pathological processes, and it is on these processes that diseases must be classified. Thus we read about tissue being disintegrated instead of about necrosis; about growth being affected rather than morbid anatomy; and about water deficiencies rather than wilts; but the result is not always very different from what one is used to. The general standard of the text is high, though rather diffuse in places. Nearly half of it was written in the United States, but there are five contributions from Europe and Asia, with the promise of substantial British participation in the two volumes still to be published.

W. C. Moore

MYCORRHIZA

The Biology of Mycorrhiza

By Dr. J. L. Harley. (Plant Science Monographs.) Pp. xiv+234+11 plates. (London: Leonard Hill (Books), Ltd., 1959.) 55*s*. net.

THIS publication is an important event in the progress of research on mycorrhiza. Dr. Harley provides us with a clear account of what is known in this field (hitherto notorious for its confusion) and shows also where the considerable gaps in our knowledge lie. It will be surprising and disappointing if this stimulating monograph does not benefit both the quantity and quality of future research on mycorrhiza.

It is about eighty years since Frank first noted the widespread association of root and fungus which he termed 'mycorrhiza'. Since then a great deal of work and thought has been given to these organisms, but perhaps without commensurate increase in understanding. Difficulties are obvious: the structures are hidden in the soil; the small scale, especially of some of the fungus partners, hinders anatomical study; culture of one partner without the other is often difficult or impossible; and certain appropriate techniques have only recently become available. Apart from such technical difficulties, this complex subject seems to have attracted an excess of sterile hypothesis and slipshod thought.

It is the virtue of Dr. Harley's monograph that it carefully points out these areas of imperfect experimentation and thought (and language: the index includes "Thamniscophysalidophagy, term not used on page 195"). Having done so, it avoids further treatment of these aspects, and concentrates on the firmer ground, incidentally revealing outstanding problems where research may most usefully be applied. In several fields Dr. Harley has been able to develop arguments that enhance our appreciation of the significance of mycorrhizal phenomena; for example: (1) he has pointed out that all roots growing in soil are inevitably surrounded by and interacting with special local populations of micro-organisms, and that the mycorrhiza is a special case of this general relationship; (2) studies made by Dr. Harley and his students using labelled phosphate and excised beech mycorrhizas enable him to outline the general mechanism by which ions are actively absorbed and accumulated by the fungal sheath and afterwards transferred to the root; (3) by stating the evidence for and against nitrogen fixation by the fungi of ericoid and orchid mycorrhizas, he makes it clear that the widespread acceptance of the hypothesis that these organs fix nitrogen is unjustified.

The literature of mycorrhizas is scattered, since it enters the fields of plant physiology and anatomy, mycology, forestry, and soil science. Some of the publications are not easily available, and a number are in languages that most workers cannot read. Consequently the collection of recently published material in this monograph will be particularly useful to those embarking on research. For students, too, this book is bound to be valuable, though it would have been more attractive and useful to them if the plentiful illustrations promised by the publishers were in fact present. The only anatomical figures are a transverse section and partial longitudinal section of beech mycorrhizas, and three figures of aseptate hyphæ and vesicles. This deficiency is only partially alleviated by some plates.

The mycorrhizal condition is not merely an absorbing problem for academic research. It is a condition that is "at least as usual amongst the seed plants as the uninfected state"; and phycomycetous mycorrhiza, of which astonishingly little is known, occur in many important crop plants—date-palms, cocoa, tea, coffee, legumes, cereals, and grasses. If the symbiosis is highly integrated it may be satisfactory, for ecological and agronomic purposes, to treat the dual organism as a single unit; but it is not certain that integration is as complete as this. For applied purposes, therefore, as well as in its own right, mycorrhizal research is needed; and for such research this excellent book will be a stimulus and guide.

J. Warren Wilson

THE BANANA

Bananas

By N. W. Simmonds. (Tropical Agriculture Series.) Pp. xvi+466+93 photographs. (London: Longmans, Green and Co., Ltd., 1959.) 45*s*. net.

A VAST amount is now known, and has been written, about many of the major crops. When that crop is an exotic one like the banana, cultivated virtually throughout the tropical belt and also in many sub-tropical regions as a prime source of food and other commodities, then we have indeed an unusually rich and varied subject for the scientific

writer, especially if his interests are liberal. Bananas, in their considerable variety and diversity, afford interesting materials not only for the professional botanist and agriculturist but also for those who concern themselves with the early history of man and his migrations. In some parts of the world bananas are, of course, very big business. An adequate account of all these aspects, and many others, is now available in the up-to-date book prepared by Mr. N. W. Simmonds, formerly senior cytogeneticist at the Imperial College of Tropical Agriculture, Trinidad.

The book contains chapters on the general botany, morphology, anatomy, composition, and systematic position of species of the genus *Musa*. Other chapters deal in a very thorough manner with the classification and nomenclature of wild and cultivated varieties, and with the cytology, genetics and breeding of commercially useful hybrids. These constitute the most important scientific parts of the book, including as they do much of the author's personal contribution. There are also accounts of the agricultural management of the crop, its major diseases and pests, and the handling and ripening of the final product—the bunch and individual fruits. Of course, the banana is a very remarkable plant and the general reader will almost certainly derive both pleasure and interest from the chapters dealing with the history of the industry and the uses to which the fruit can be put; for bananas can not only be eaten as dessert fruits: they can be cooked in various (?) attractive ways, made into sweets and powder (flour), dried into 'chips' and 'figs', brewed into beer, and so on. Such a commodity could scarcely fail to have many medico-magical uses. The book is handsomely illustrated by plain and coloured photographs and line drawings, while certain general phenomena are depicted by means of ingenious diagrams.

By his novel and attractive treatment of this major tropical plant, Mr. Simmonds has contributed an important work of scholarship, rich in its botanical and scientific content; and because of its directness and lucidity, it may well have a more general appeal.

The book will certainly be read with appreciation by members of the planting community and by research workers. Indeed, in my opinion, no book on the banana of equal status and content has hitherto been published. C. W. WARDLAW

TROPICAL ANIMAL HUSBANDRY

An Introduction to Animal Husbandry in the Tropics

By G. Williamson and Dr. W. J. A. Payne. (Tropical Agriculture Series.) Pp. xix+435+48 plates. (London: Longmans, Green and Co., Ltd., 1959.) 48*s*. net.

THIS is a book with a large number of facets. While written for the animal husbandman in the tropics, for whom it will be invaluable, it incidentally gives much information of physiological, zoological, nutritional and sociological interest.

The earlier chapters are devoted to scientific information on conditions in the tropics—a description of climates and the direct effects of them on the animal through solar radiation, temperature, humidity and daylight hours, as well as the indirect effects through feed supply. Prevalent infections and insect-transmitted diseases with remedial measures are described. Nutrition is approached from a wider angle than is to be found in the usual text-book. Prominence is given to things such as water supply—the number of days different species can do without it and the amount they drink. Types and nutritional value of vegetation to be found under different climatic conditions are described. The rapid growth and seeding of plants in the tropics and the longer growing period in many areas which lead to practices such as burning and standing hay are discussed and better methods suggested.

In the chapters devoted to husbandry some typical tropical breeds in each species are described. The whole range of husbandry practices from the very primitive to modern methods is detailed—from the kraaled cattle at night in Africa, where short-day grazing limits production, to the modern methods adopted by the Aarey Milk Colony in Bombay; and from the primitive fermentation method of hatching hens eggs to the use of the modern incubator. Comparisons of production in temperate as compared with tropical zones are also given. While in Western Europe 660 lb. of milk are produced per capita of the human population, Africa only produces 46 lb.; again, there are five times as many sheep, only half as many goats and twice as many pigs in the temperate as compared with the tropical zones.

Of particular interest are the chapters written by experts on special subjects. The buffalo produces most of the milk consumed in India and Egypt in spite of the fact that its heat-regulating powers are not so good as those of the zebu. Camels produce a calf only every other year and the period of rut in the male, induced by lengthening days, lasts only for a period of about three months; if deprived of water they can drink up to 20 gallons at a time, an amount which would result in water intoxication in other species. An account of the African nomad, the circumstances which cause his mode of life and ways in which he could be settled are also outlined.

Throughout the book references are given to the more important original papers dealing with livestock production in the tropics. JOHN HAMMOND

ORGANIZATION, CONTROL AND SYNTHESIS IN MICRO-ORGANISMS

Annual Review of Microbiology

Vol. 13. Edited by Charles E. Clifton, in association with Sidney Raffel and Mortimer P. Starr. Pp. viii+553. (Palo Alto, Calif.: Annual Reviews, Inc., 1959.) 7 dollars.

THE past two decades have seen the transformation of microbiology from an 'applied science' to a subject which is making fundamental contributions to many and varied fields of biological research. As the ever-increasing mass of publications so amply testifies, it is a subject still in its logarithmic phase of growth and thus the demand for concise and critical surveys of recent advances becomes greater year by year; for the past twelve years "Annual Reviews of Microbiology" have met this demand. The thirteenth volume in this series will disappoint no one; it

contains twenty-one articles which cover aspects of microbiology ranging from the biosynthesis of macromolecules to the intriguing subject of 'unicellular clocks'.

Microbiological research in recent years has been dominated by the problems of biosynthesis, intracellular organization and mechanisms of biological control; one third of the contributions in this volume are concerned with these questions. Roberts, McQuillen and Roberts, in an article entitled "Biosynthetic Aspects of Metabolism" present an admirable account of current views on the synthesis of protein, ribonucleic and deoxyribonucleic acids. They discuss recent advances under four headings: first, those made by using purified enzyme preparations, second, reactions which are observed with cellular fragments, third, reactions of intact cells, and finally, the effect of various inhibitors and certain biological or physical disturbances on biosynthetic reactions. A more specialized aspect of the biosynthesis of macromolecules, the synthesis of antibodies, is discussed in an article by Bussard.

Genetic control of biosynthesis forms the subject-matter of two reviews. The first, by Demerec and Hartman, surveys knowledge of the complex structure and chromosomal arrangement of gene loci concerned with sequential steps in biosynthesis. In the second, Hartman and Goodgal deal with the transfer of genetic material in bacteria, mediated either by cellular contact, free deoxyribonucleic acid or bacteriophage. The genetics of bacteriophage are discussed in a separate contribution by Bresch. Another aspect of biological control is presented by Hastings under the heading of "Unicellular Clocks", in which he discusses the persistent diurnal rhythms which influence phototaxis, luminescence, sexual activity and cell division in certain flagellates and ciliates.

Ultimately, the biochemists' concepts of synthetic mechanisms and the geneticists' views of controlling mechanisms must be correlated with the cytologists' interpretation of intracellular organization. Clearly much remains to be discovered before such a correlation can be completed; however, Mitchell has attempted to fit together many of the available pieces of the 'jig-saw puzzle' under the title "Biochemical Cytology": this is a most stimulating contribution.

Catabolic aspects of metabolism surveyed include: fermentative metabolism (Rabinowitz), sulphate reduction by bacteria (Postgate) and aspects of terminal respiration in micro-organisms (H. L. Kornberg). This latter review provides a valuable survey of evidence for the occurrence of the tricarboxylic acid cycle in micro-organisms and indicates some of the difficulties and pitfalls encountered in the study of microbial oxidative processes.

Other topics reviewed include: plant diseases (three articles); new antibiotics and the use of antibiotics in food preservation; the biology of Tetrahymena; the physiology and development of Phycomycetes; non-specific resistance to infections in animals; immunological tolerance; new viruses; microbiological aspects of tissue culture.

There can be no doubt that this volume will be of value to all who observe the devious ways of micro-organisms. The editors are to be congratulated for selecting such a wide and interesting range of topics and the reviewers for their courage and skill in attacking, sorting and surveying such a formidable mass of data.

B. A. Newton

BIOCHEMICAL DATA

Data for Biochemical Research

Edited by R. M. C. Dawson, Daphne C. Elliott, W. H. Elliott and K. M. Jones. Pp. xiii+299. (Oxford: Clarendon Press; London: Oxford University Press, 1959.) 63*s*. net.

SCIENTISTS owe much to the patient endeavours of authors and editors of reference works such as "The Handbook of Chemistry and Physics", "Documenta Geigy Scientific Tables" and the "Merck Index". In the present book information which is of particular interest to biochemists has been collated.

The subject-matter is sub-divided into fifteen sections, namely: table of biochemical compounds; enzymes commonly used as laboratory reagents; buffers and physiological media; methods for the detection of biochemical compounds on paper; the properties of some ion-exchange resins; isotopic data; manometry; nomograms for manometer constants; ammonium sulphate solutions; miscellaneous reagents, tests and recipes; acid-base indicators; table of normalities; autoclaves: temperature-pressure conversion table; miscellaneous formulæ; international atomic weights, 1955.

More than half the book is devoted to the first section, which tabulates various features and properties (structural formula, molecular weight, solubility, optical rotation, etc.) of about one thousand compounds of biochemical interest. The compounds are arranged in nineteen different groups, beginning with amino-acids, peptides and related nitrogenous compounds and ending with macromolecules. The type of information provided varies according to the particular needs of the group. Thus, spectral data are provided for porphyrins and related compounds but not for lipids and fatty acids. Wherever possible, general group references and references to methods of preparation and estimation are given and a column of general remarks provides additional useful information.

The chief merits of the book appear to lie in the first section and that on methods for the detection of biochemical compounds on paper. In the latter section the compounds are grouped appropriately, numerous references are given and the information is presented in a readily accessible form. Some of the remaining sections are of less-certain value and material sometimes appears to have been selected in an arbitrary manner.

The editors have wisely stated that the book is not intended to be an exhaustive work of reference and, indeed, many readers will be disappointed that their own particular interests are not catered for. In spite of the editorial proviso it is surprising, for example, that such well-known compounds as fibrinogen, chitin, hyaluronic acid and chondroitin sulphates *A*, *B* and *C* are not listed under 'Macromolecules' in the first section. The important phosphato-sulphate nucleotides, discovered in 1956 by Lipmann's group, are not listed with other nucleotides or, indeed, anywhere in the book. The section on properties of some ion-exchange resins could surely have been extended to provide information on the important cellulose ion-exchangers.

Several authors have contributed to the book and it is perhaps not surprising that some inconsistencies appear. Thus in the first section, under "Carbohydrates and Related Compounds", the Haworth ring-form is used to formulate the compounds. In

contrast, under "Phosphate Esters, including Nucleotides", the less appropriate Fischer-Tollens ring structure is generally used. Hydroxymaleic and hydroxyfumaric acids are correctly formulated in *cis* and *trans* forms respectively. The unsubstituted acids, however, are given identical structures.

As a complete reference work for biochemists the book has obvious limitations. However, as an adjunct to the works mentioned in the opening paragraph of this review, the book will undoubtedly be of value to most biochemical laboratories.

K. S. DODGSON

GENERAL BIOCHEMISTRY

Traité de Biochimie Générale

Par M. Javillier, M. Polonovski, M. Florkin, P. Boulanger, M. Lemoigne, J. Roche et R. Wurmser. Tome 1 : Composition Chimique des Organismes. Premier Fascicule : Pp. iv+1–706. Deuxième Fascicule : Pp. iv+707–1475. (Paris : Masson et Cie., 1959.) Broché 22,000 francs ; Cartonné toile 24,500 francs les deux volumes.

THE undertaking of a five-part treatise on general biochemistry is a formidable enterprise. The rapidity with which the subject is developing at the present time sometimes induces in potential authors of books on it a continued temptation to procrastinate. Their answer to a suggestion that they might write a book often follows this sort of pattern : "The subject, particularly those parts of it in which I am most closely concerned", they say, "is so rapidly advancing at the present time that no general review of it is worth while recording in a book" . . . "But in one year's time, perhaps two, the air should have cleared and I shall be able to write an account which is much more satisfactory than anything that can be produced to-day". It is always to-morrow that there will be jam for tea ; never to-day.

Fortunately, not all are so faint-hearted or cautious. It is perhaps natural that, in the language of the country which bred the first modern encyclopædists, a group of distinguished French-speaking biochemists, most from France itself, should have decided to undertake the task of imprisoning within the limits of a few thousand pages the essentials of a subject which, perhaps more than any other, resembles Proteus in modern guise.

The Board of Editors consisted of Profs. M. Javillier, M. Polonovski, M. Florkin, P. Boulanger, M. Lemoigne, J. Roche and R. Wurmser, with P. Boulanger and J. Polonovski acting as secretaries. Although Prof. M. Polonovski was killed in a road accident soon after the plans had been agreed, and M. Javillier also died before the completion of the work, the remaining editors decided to continue along the agreed lines, and the first section, in two parts, is now published. The complete work will fill three tomes, totalling five parts altogether.

The two parts of the first section are devoted to a survey of the chemical composition of living matter. Introductory chapters deal with the elementary composition of organisms and their mineral constituents, and then follow chapters on carbohydrates, lipids, in which are included sterols, steroids, carotenoids, terpenes and terpenoids, and on organic acids and phenols. Some of Part 1 and most of Part 2 are taken up with treatises on amino-acids, peptides and proteins. A section on substances attached to proteins includes a useful review of alkaloids. Part 2 concludes with a discussion of the associations formed between the substances dealt with, for example, lipid-protein complexes, antigen-antibody and enzyme-substrate complex formation, and a brief discussion of the borders of biochemistry with respect to organization and morphology.

The editors and authors aim to present the principles of biochemistry which in their view are essential for students of chemistry and physiology, pharmacy and medicine, agriculture and technology. How far such an aim has been achieved will be clear from the completed work ; but on the basis of the first two parts it can be said that no reason has yet emerged why the authors should not succeed in their ambitious enterprise.

F. G. YOUNG

ANTIGENS, TRANSPLANTATION AND TOLERANCE

Biological Problems of Grafting

A Symposium sponsored by the Commission Administrative du Patrimoine Universitaire de Liège and the Council for International Organizations of Medical Sciences. Pp. xii+453. (Oxford : Blackwell Scientific Publications, 1959.) 50*s*. net.

A SYMPOSIUM on the biological problems of grafting was held in Liège during March 18–21, 1959, under the chairmanship of Prof. P. B. Medawar. The number of participants was limited and most of them presented papers which, together with the relevant discussions, are now published in full. A total of twenty-nine papers was given, ranging over most of the current controversial problems in transplantation. These include the identification of the transplantation antigens, the investigation of the mechanism of the homograft reaction, the means by which tolerance may be induced and its attendant difficulties of the runt syndrome and homologous disease.

A review by P. B. Medawar on iso-antigens gives a very useful introduction to this subject, and the papers by P. A. Gorer and J. H. Berrian and R. J. Jacobs detail important recent experimental work on transplantation antigens. The similarity between skin transplantation immunity and hypersensitivity of the delayed type in guinea pigs is discussed by Brent, Brown and Medawar ; they consider that their results support the hypothesis that reaction against skin homografts is mediated through cells rather than through serum antibodies. In a very interesting paper R. T. Prehn describes the effects of antigen dosage, route of administration and splenectomy on homograft reaction. He speculates that the spleen may play an important part in the prevention of autoimmunization as well as in the 'enhancement' phenomena by producing an immunity-inhibiting antibody.

Hasek reviews the various methods of inducing tolerance, and Haskova reports that although transplantation antigens are present in cell-free extracts such extracts fail to induce tolerance. Mitchison describes some original experiments on blood transfusion in the fowl and shows that in this system the persistence of tolerance is dependent upon the persistence of the antigen. This paper provoked interesting and stimulating discussion on the nature and mechanism by which tolerance is induced and sustained.

Several papers dealt with the allied problems of the runt syndrome and homologous disease, and ample evidence is presented to support the thesis that both these phenomena are due to the immunological reaction of foreign cells against a tolerant host. Simonsen and Jensen describe an ingenious graft versus host assay, and Gorer and Boyse suggest that the destruction of host lymphoid cells and tissues may be in the nature of an allergic reaction.

One gains the impression that this symposium was of great interest and benefit to those who participated, since many of the most interesting ideas and speculations were brought out in the addenda and discussions. The editors, organizers and publishers are to be congratulated on the speed of publication (the book was available at the end of last year) although the presentation of the book has suffered thereby. There are several errors in the list of contents and the absence of an index is a marked disadvantage both to the general reader and to those seeking a work of reference. The composition and arrangement of the twenty-nine papers varies considerably; only eleven had summaries and of the four papers in French only two had summaries in English. The collection of the material under appropriate subject headings would have been advantageous. For example, although the problem of overcoming the practical difficulties inherent in transplantation is considered in some papers the data are not presented in such a way as to be readily accessible to surgeons and others with little time to read all 453 pages.

However, this is a comprehensive volume of papers for workers in this field and the reviews of recent work would be useful for those already familiar with current trends. D. M. V. Parrott

GENERAL PHYSIOLOGY

Principles of General Physiology

By W. M. Bayliss. Fifth Edition by Dr. L. E. Bayliss. Vol. 1. Pp. xiii+520; Vol. 2. Pp. xxii+848. (London: Longmans, Green and Co., Ltd., 1959 and 1960.) Vol. 1, 55*s*. net. Vol. 2, 90*s*. net.

A Textbook of General Physiology

By Dr. Hugh Davson. Second Edition. Pp. xvi+846+32 plates. (London: J. and A. Churchill, Ltd., 1959.) 84*s*. net.

IN 1916 appeared the first edition of "Bayliss" and in 1951 that of Davson. Claude Bernard had defined general physiology as "the study of phenomena common to plants and animals". William Bayliss, in the first edition of his "Principles", had adopted Burdon-Sanderson's definition "the study of the endowments of living materials". Dr. Davson indicated that in practice Bayliss restricted this study to those aspects of living material which showed some immediate prospect of being described in terms of the known laws of physics and chemistry.

He referred to the fact that Dr. Leonard E. Bayliss, son of Sir William Bayliss, was preparing a fifth edition of his father's "Principles". Despite the years since it was first written (1916) and since its last edition in 1924, it still led the field. This fifth edition shows changes in format, in ambit and approach, so marked that even the publishers seem uncertain as to the author. On page iii (the title-page) it is described as by L. E. Bayliss; on page iv as the "Fifth Edition of W. M. Bayliss's Principles by L. E. Bayliss". What does it matter? The genetic interrelationship is so close that the initials are almost of no importance. Dr. Leonard Bayliss has had a bigger task, which he has accomplished by scrapping entirely the old book and writing two volumes, one largely on physical chemistry in its own right and a second (entitled "General Physiology") on the applications in living material. In this, he has been singularly successful, for the internal classification within these volumes is a physiological classification based on function and not on morphological systems. This he has illustrated by studying phenomena at all levels in botany, zoology and microbiology. He has some beautiful discussions on the applications of modern physics in even more modern biology, particularly in the chapter on servo-mechanisms.

Dr. Davson's book has three new chapters, on "Sensory Response", on "Excitability of Cardiac Muscle" and on "Electrical Activity in Smooth Muscle". He stresses functional energy in metazoa and particularly in the integrated vertebrate. He is therefore most informing when discussing the underlying biophysics of mammalian physiology. He has also been able to focus on the last decade aspects of cell structure, particularly the work of Watson and Crick in regard to inclusion bodies, nucleo-protein, the cell membrane, protein synthesis and viruses.

General physiology is splitting into biophysics and biochemistry, and biomathematics. The recent finding of polarization in light coming from Mars, suggesting absorption bands reminiscent of carbon–hydrogen chains and of cellulose, points to a bio-astronomy. The physicist is making serious endeavours to utilize models as an aid to interpretation of the nervous system. Sir Cyril Hinshelwood, in his presidential address to the Royal Society last year, suggested the time is ripe to apply modern scientific disciplines to the study of the paranormal phenomena of extra-sensory perception. The all-in-all book embracing the whole of general physiology is going to be more and more difficult to write and maintain.

These two branches, from the root stem Sir William Bayliss, are most impressive; each author has had a somewhat different task, each has worked differently and each produced a book that is invaluable. What is both interesting and important is that, while different, they integrate and reciprocate with each other and the possession of one is no reason for not possessing the other. A. St. G. Huggett

ANALYTICAL CHEMISTRY OF POLYMERS

Analytical Chemistry of Polymers

Edited by Gordon M. Kline. Part 1: Analysis of Monomers and Polymeric Materials: Plastics—Resins—Rubbers—Fibres. (High Polymers: a series of Monographs on the Chemistry, Physics and Technology of High Polymeric Substances, Vol. 12, Part 1.) Pp. xviii+666. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1959.) 125*s*.

INDUSTRIALLY, the term high-polymers covers vinyl plastics, condensation polymers—important in the synthesis of fibres, resins and drying oils—natural and synthetic rubbers, proteins, ion-exchange

resins and many other special classes. In each of these fields special procedures for physical and chemical analysis have been developed and their description is widely scattered throughout the literature, in industrial specifications and in research reports.

This book, which is the collective work of twenty-six authors who are all members of the staff of American industrial concerns, brings together in one volume methods of analysis which have been used successfully in the determination and testing of commercial monomers and polymers. The methods for the determination of physical properties and chemical composition of each of the major industrial polymers, namely, acrylic plastics, alkyls, amino-resins, cellulose derivatives, epoxy resins, ethylene and fluoroethylene polymers, furan resins, natural resins, phenolic resins, polyamides, polyesters, proteins, rubbers (natural and synthetic), silicones, styrene monomers and polymers, vinyl polymers and co-polymers, and synthetic and natural fibres, are summarized in a separate chapter.

In each case methods are described for the assay and determination of pertinent impurities in the monomers; this is followed by a discussion of analytical problems of identification and characterization of the chemical composition and physical properties of the polymers. Special chapters are devoted to plasticizers, ion-exchange resins and drying oils. In general, the main features of the analytical method and apparatus used are described and the reader is referred to the original publication for detailed directions. In cases where the methods have not been previously published, full details of the procedure are given.

The book provides the best survey and compilation I have seen, and it should be of great use to the practising polymer chemist and analyst. The editor has been successful in bringing together a very valuable collection of information on polymers, and in the second volume, which is in preparation, it is intended to cover the subjects of molecular structure determination, chemical group analysis and identification procedures for polymers.

C. E. H. Bawn

THE ORGANIC CHEMISTRY OF SULPHUR

Aspects of the Organic Chemistry of Sulphur
By Prof. Frederick Challenger. (Organic Chemistry Monographs.) Pp. vii+253. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1959.) 40*s*.; 7.50 dollars.

A CONSIDERABLE portion of Prof. F. Challenger's researches have been concerned with organic derivatives of sulphur, and a book on this subject written by him is greatly welcome. He has chosen six topics to discuss, each as a separate chapter, and naturally occurring organic derivatives occupy a prominent position. Many of the subjects discussed are those which he has studied intensively in the course of his own work, and upon which he can therefore write with particular authority.

The first two chapters, on "Simple Organic Compounds of Sulphur. Properties, Preparation and Biological Significance" and "Natural Sulphonium Compounds, Sulphides, Sulphoxides, Mercaptans and Sulphido-amino Acids" respectively, cover appropriately the widest fields, but even in discussing these comparatively simple classes of compounds the author has a fund of very interesting information on various points which will probably be novel to many organic chemists.

The chapter on "Sulphur Compounds of Petroleum" affords an excellent account of this subject, and the discussion of the desulphurization of organic compounds by Raney nickel, its mechanism, stereochemistry, and various applications is of great value.

Each of the remaining three chapters forms a complete monograph in itself. "The Natural Mustard Oil Glucosides and the Related *Iso*thiocyanates and Nitriles" starts with a very interesting historical review of the early work on oil of mustard, and then covers the modern chemistry of a surprisingly wide variety of compounds in its 146 pages. Prof. Challenger has worked on biological methylation since 1931, and his chapter "Biological Methylation with Particular Reference to Compounds of Sulphur" gives, as one would expect, an authoritative and thoroughly comprehensive account of this subject. Among the many subjects discussed are the mechanism of biological methylation, the transmethylation from methionine and choline, and the formation of 'active methionine' in enzyme systems and its synthesis in the laboratory: the chapter finishes with a discussion of the metabolism of ethanethiol, and the possible mechanism of its anti-tubercular effect. The last chapter is devoted to "Co-enzyme A, its S-acetyl Derivative and Related Compounds."

One quality of this book which greatly impressed me is that it is refreshingly readable. This arises partly from the author's clear natural style, and partly from his gift of presenting and discussing a considerable amount of material in a deceptively unhurried manner, so that, although no words are wasted, the reader never feels that he is being 'crowded'.

This high standard of writing, combined with the author's wide knowledge, makes one wish that he would now, with greater leisure, write a volume which would be the sulphur analogue of Sidgwick's "Nitrogen", that is, a volume in which the preparation and properties of the various classes of organic sulphur compounds would be systematically discussed, and many features of their chemistry critically assessed, without any attempt to achieve a comprehensive account. Several chemists have started on this task, and have fallen by the wayside *en route*: Prof. Challenger's vigour and enthusiasm would take him safely—and still in eminently readable style—to the end of the task.

F. G. Mann

LIGHT-INITIATED ORGANIC SYNTHESIS

Präparative Organische Photochemie
Von Prof. Alexander Schönberg. (Organische Chemie in Einzeldarstellungen, Band 6.) Pp. xii+274. (Berlin: Springer-Verlag, 1958.) 58 D.M.

PHOTOCHEMISTRY is perhaps still considered to be essentially the province of the physical chemist, yet during the past twenty-five years a vast amount of information has accumulated on the use of light to initiate reactions leading to the formation of relatively simple organic molecules (as distinct from polymers of high molecular weight). Prof. A. Schönberg

directs attention through his book to the scope and utility of what is rapidly developing into an important section of organic chemistry.

The topics covered by Prof. Schönberg include photo-isomerism; photo-dimerization; photochemical oxidation reactions; addition reactions with olefins and acetylenes; photochemical reactions involving ketones, acids, acyl halides, anthracene derivatives, organic halides, etc.; cyclization reactions; photohalogenation; and photochemical reactions of nitric oxide, nitro-compounds, diazo-, diazonium-, and azo-compounds, sulphur, arsenic, and mercury compounds. Reactions leading to the formation of high polymers are excluded as being outside the scope of the book. Prof. G. O. Schenk's chapter on equipment available on the Continent is of less interest to British chemists than other chapters, but will nevertheless provide useful ideas for the design of photochemical reactors and other apparatus. The book was completed in mid-1957, and literature up to the end of 1957 is included as an appendix.

Experimental details are given for numerous syntheses, and the high yields often obtained will encourage many organic chemists; however, it will often be necessary to read the original literature to ensure that the correct technique is being used.

Many of the reactions described involve free radicals as intermediates, and although a brief summary of the mechanism or the probable course of the reaction is often given, the author wisely restrains himself from over-emphasizing this aspect, and concentrates on the preparative use of photochemistry. For full appreciation of the very many reactions discussed it will thus be necessary for a newcomer to the field to read a standard text on free-radical chemistry.

This book is a useful addition to chemical literature, even though the approach is essentially—and sometimes disappointingly—non-critical. The printing and general lay-out are excellent, making the book easy to read and to use for reference. Some will doubtless wish for an English translation; most would prefer a price lower than £5 2*s*. 0*d*. (4½d. a page).

R. N. Haszeldine

CHEMICAL NOMENCLATURE

An Introduction to Chemical Nomenclature

By Dr. R. S. Cahn. Pp. viii+96. (London: Butterworths Scientific Publications, 1959.) 10*s*. 6*d*.

THE ever-increasing tempo of scientific research the world over creates *pari passu* new problems of communications between scientists. New phenomena providing evidence of a multiplicity of yet smaller and more perplexing sub-atomic particles—the traditional domain of the physicist; new matter at molecular level formed by the almost infinite range of permutations and combinations of the near hundred atoms of the periodic table—the chemist's field; each demands the utmost care in selecting terms with which to describe them if a scientific Babel is to be avoided. In the field of chemistry the International Union of Pure and Applied Chemistry has, through its various nomenclature committees, sponsored much excellent and fruitful study to which Dr. Cahn from Great Britain has contributed in no small measure. The present booklet is timely, especially in view of recent new developments in inorganic chemistry and the concomitant nomenclature changes. While there are no major changes of principle in organic nomenclature, it is in the inorganic field that older chemists will have to accustom themselves to some radical departures from old familiar names for common substances if they are to be systematic. But the Union is realistic when it refers to a system as "in use but not recommended" and Dr. Cahn is not remote from everyday chemical life when he says, "Probably it will die hard, for ferrous chloride comes more glibly off the older tongue than iron (II) chloride or ferrum (II) chloride or even iron dichloride; but it will probably die in time". So did Charles II.

Throughout, Dr. Cahn treats the intractable problem of reconciling usage with system in a friendly sympathetic style and pedantry rarely obtrudes. The principles are clearly stated and it should be possible for the chemist arriving at the substance $NaH(PHO_2F_2)$ to describe it correctly in his paper to the Chemical Society as sodium hydrogenhydrido-dioxodifluorophosphate, and equally for another chemist searching the indexes in the years to come to find and identify the entry. But much remains to be done, especially with the inorganic heterocycles involving P, N, B, Si, S and the rest, and Dr. Cahn and his colleagues would no doubt prefer that chemists did not spawn exotic new compounds unless they could be given a proper systematic name before a trivial (and possibly misleading) name gained currency in the literature. There is a challenge for the nomenclature or theoretical research chemist to outstrip his experimental colleague and prepare the name ready for the substance.

The organic section lucidly states current principles but contains one or two disconcerting errors. Thiocresol $C_6H_4Me.SH$ could surely never have the systematic name toluene-ω-thiol nor has glycollic acid ever been $HO.CH_2.CH_2.COOH$. Dr. Cahn rarely nods and he should correct these errors. To perplex chemists there is a Mitford-like disapproval of 'mesyl' while 'tosyl' appears to be 'U' in some places. Half a guinea for such a small booklet is the price for quality, not bulk.

H. J. Barber

ELECTRONIC STRUCTURE OF MOLECULES

Die Methoden der Molekülphysik und ihre Anwendungsbereiche

Von H. Preuss. (Fortschritte der Physik, 1 Sonderband.) Pp. vii+167. (Berlin: Akademie-Verlag, 1959.) 22 D.M.

FIRST of all, the title is wrong. For despite its label this is not an account of the methods of molecular physics. If it were, it would contain some discussion of statistical mechanics, perturbation theory, properties of angular momentum and of spin, influence of electric and magnetic fields on molecules, etc. In fact it is solely concerned with the electronic structure of molecules, the techniques used and the type of result obtained.

Dr. Preuss is already well known to workers in the field of the wave mechanics of molecules as the author of a series of three books containing the numerical values of the various Coulomb and exchange integrals which play such a large part in it. The present book could be regarded as a compendium of the fundamental methods which are involved when using these integrals.

There is an introductory chapter on what is described as "Semi-empirical Theories", followed by the two main chapters of the book, on theoretical, and semi-theoretical, calculations. This particular classification is not one that has hitherto been used to divide up the field. But it has a good deal to commend it. Previously it has been more customary to have separate chapters on the molecular-orbital method and the valence-bond method: and each chapter has covered both the *ab initio* calculations and the semi-theoretical ones. To-day, however, no one wants to flog the old horse by arguing which is the better, since we know that for an attempted accurate calculation neither is satisfactory unless it is modified to such an extent that it merges with the other. The separation chosen by Preuss corresponds much more closely with the way that present-day work is being organized. On one hand there are those who want as exact an estimate of the energy and the wave function, as can be obtained. Ideally these people will use no empirical data whatever. On the other hand there are those who want to understand the reasons why molecules behave as they do—why, for example, their colour shifts to the red on methylation, or why carbon-hydrogen bond lengths are nearly, but not quite, constant.

Of the two main chapters the 'non-empirical' one is the better and includes several theories such as the density matrix, and the method of configuration interaction, not usually covered in text-books: and also Löwdin's natural spin orbitals. But it suffers from an undue emphasis on the two-electron atom. The chapter entitled 'semi-empirical theories' seems to be rather out of balance, with several huge lists of not very important numerical results, and scarcely any serious attempt to provide a critique for the approximation being discussed. But it does give a useful survey of Moffitt's method of atoms-in-molecules: and of the free-electron gas model.

C. A. COULSON

CHEMICAL THERMODYNAMICS

An Introduction to the Study of Chemical Thermodynamics

By Prof. D. H. Everett. Pp. xx+240. (London: Longmans, Green and Co., Ltd., 1959.) 28*s*. net.

Bases Fondamentales et Applications de la Thermodynamique Chimique

Par Prof. Maurice Dodé. Tome 1: Les Principes, Les Systèmes Ideaux Gazeux, et avec Phases Condensées Pures. Pp. iv+516. (Paris: Société d'Edition d'Enseignment Supérieur, 1959.) 4,000 francs.

THE authors of these books are enthusiasts about thermodynamics, but with rather different outcomes to their enthusiasm. Prof. Everett shares the view of P. Duhem (1903) that the range of scientific studies to which thermodynamics is applicable is extremely broad. There are aspects of this universal discipline of interest to philosophers, mathematicians, physicists and chemists—we would now add biophysicists and biochemists to Duhem's list—but different treatises are needed for each of these groups of savants. This makes it particularly important to prepare for such advanced treatises by introductory work carefully designed to lead in the appropriate direction. Everett's book leads to chemical thermodynamics. He is well aware of the confusion and boredom induced in future chemists by many introductory treatments of thermodynamics which stress the physical, philosophical or pseudo-engineering aspects, or which over-emphasize its mathematical elegance and rigorousness. To avoid these educational mishaps, Everett's text starts by getting readers interested in the use of thermodynamic equations, and familiarized with accurate and quite complex symbolism before they are led to examine the fundamental laws of thermodynamics with any degree of profundity. The book is designed to serve the needs of university students up to pass degree level in chemistry, or as a subsidiary to main biological subjects. It leads on to more advanced treatises in a very effective way. The chapter on "Conditions of Chemical Equilibrium" seems particularly noteworthy in an elementary book of this kind; there are many other useful sections. Not every reader will find mechanical analogies of thermodynamics in the text easier to follow than their thermodynamic counterparts, but there is no doubt that the book as a whole is a very valuable contribution to the teaching of 'chemical' thermodynamics in the all-important elementary stages. The book should promote confidence and accuracy in students, though the examples for working given in the appendix should probably be amplified and diversified for use in a teaching course.

Like Prof. Everett's book, the text by Prof. Dodé is intended to serve the needs of students of chemical thermodynamics, in this instance chiefly industrial chemists and chemical engineers. British readers will find it a much more untidy and probably a much less useful work. It is less carefully contrived to induce a strong and accurate grasp of chemical thermodynamics by elementary students. Dodé's book quite rightly stresses the usefulness and power of De Donder's affinity function and refers rather charmingly to "L'affinité chimique, cette vieille notion restée si longtemps d'ordre sentimental". But the text contains much extraneous matter of mainly physical, semi-historical or philosophical nature. Calculations of chemical equilibria are described in very considerable detail. Some of the material quoted seems rather out of date. More powerful and convenient procedures could be found, particularly in some of the American text-books quoted by Everett for further reading.

A. R. UBBELOHDE

A STRUCTURAL TOOL FOR THE CHEMIST

Nuclear Magnetic Resonance

Applications to Organic Chemistry. By Prof. J. D. Roberts. (McGraw-Hill Series in Advanced Chemistry). Pp. viii+118. (London: McGraw-Hill Publishing Company, Ltd., 1959.) 46*s*. 6*d*.

THE nuclear magnetic resonance spectrum of an organic liquid, observed under high-resolution, provides the organic chemist with a pattern of lines characteristic of the molecule. The position and intensity of the lines and their multiplet splitting can in favourable examples tell him what groups are present in the molecule, and how they are joined together. He thus has yet another tool to help him to identify a product, confirm or reject a structure, distinguish between isomers, detect and measure chemical exchange, and determine the kinetics of a

reaction. The timely development by Varian Associates of the necessary commercial instrument led to rapid and widespread exploitation of the method by organic chemists, particularly in North America.

Although there are a number of learned works which dwell on the physical theory and practice of the phenomenon there was no book which provided a simple introduction to the less mathematically minded chemist. Prof. Roberts's very readable monograph fills this want. Apart from an appendix there are only six equations in the book. The essentials are introduced in a few well-chosen words, illustrated clearly, and doubtless expensively, by diagrams in three colours. It is assumed that the reader will be using the crossed-coil detection system, an assumption which was generally correct for this type of work in the past, but which is becoming less justified now that single-coil spectrometers are finding their way on to the market. The organic chemist is given an attractive presentation with well-chosen examples of what this new tool will do. The physicist is no less fascinated by the account of the chemical applications by a practising chemist. The book closes with an intriguing set of problems with which the reader is invited to beguile the time by identifying twenty pure compounds from their proton resonance spectra given only their molecular formulæ.

E. R. Andrew

THEORY AND PRACTICE OF SEDIMENTATION

Ultracentrifugation in Biochemistry

By Howard K. Schachman. Pp. xii+272. (New York: Academic Press, Inc.; London: Academic Press, Inc. (London), Ltd., 1959.) 8·80 dollars.

THIS monograph is very welcome. The bibliography lists more than two hundred papers dealing with technical innovations, new applications of sedimentation techniques and modifications and extensions of sedimentation theory which have appeared since the publication of Svedberg and Pedersen's original book on the ultracentrifuge. It is a great asset to have this mass of work organized and critically discussed.

Dr. Schachman has restricted himself primarily to the description of the principles underlying the use of the analytical ultracentrifuge (preparative centrifugation is not mentioned) and to a survey of the many applications which are of interest to biochemists. Throughout the monograph, though, the emphasis is on problem and technique rather than on the biochemical value of the results. Indeed the index contains only one entry relating to a specific solute, human serum, and this reference deals with a remarkable boundary anomaly which shows how difficult it can be to assess relative concentrations in a multicomponent system. The absence of data on specific macromolecules is perhaps inevitable, since there are very few results in the literature which meet the stringent requirements of an error of only a few tenths of a per cent which the author demonstrates is now technically possible, and very few published photographs of schlieren boundaries will bear comparison with the beautiful examples to be found in this book.

A comparatively short section on experimental aspects includes a description of the merits and uses of the different types of cell now available and a general discussion of the principles and practical limitations of the schlieren, absorption, interferometric and Lamm scale optics. Useful practical advice is also to be found in the later chapters. The interpretation of sedimentation data is dealt with succinctly, the reader being referred to the several excellent reviews available for more detailed discussion. The greater part of the monograph is devoted to an exposition of theory and practice in sedimentation velocity and sedimentation equilibrium experiments and the increasingly important method of determining molecular weights by the method of Archibald. In the section on sedimentation velocity experiments a clear differentiation is made between those aspects of analysis which are based soundly on theory and those, for example the extrapolation of results to infinite dilution, which are still essentially empirical. There are surprisingly large fields which have as yet received little or no theoretical investigation. The complexity of the computations required to derive all the information possible from any one set of experiments is well brought out and makes one echo the author's hope that some of the labour will be reduced by the development of automatic scanning and registration techniques to replace the photographic methods now in use.

It is evident from the steady stream of papers now appearing that the dramatic developments in the application of sedimentation techniques to biochemical problems which has occurred during the last decade has by no means ended. Dr. Schachman's monograph provides an admirable basis for the appreciation and assessment of future work.

K. V. Shooter

CHEMICAL ANALYSES OF ROCKS

Petrochemische Berechnungsmethoden auf Äquivalenter Grundlage

Von Prof. Conrad Burri. (Methoden von Paul Niggli.) (Lehrbücher und Monographien aus dem Gebiete der Exakten Wissenschaften. Mineralogisch-Geotechnische Reihe, Band 7.) Pp. 334. (Basel und Stuttgart: Birkhäuser Verlag, 1959.) 38 Swiss francs; 38 D.M.

THIS well-produced volume deals with methods of recalculating chemical analyses of rocks (chiefly igneous and metamorphic rocks) on a comparative basis, and the methods discussed are mainly those devised by the late Prof. Paul Niggli, of Zurich, though some reference is also made to the calculations of T. F. W. Barth and P. Eskola on the basis of anion percentages and standard cells.

The book is the most complete treatment of the methods of calculating the so-called Niggli values (*si, al, fm, alk* and so on) and of their use which has so far appeared, a use which has had a considerable vogue among European petrographers, but only a limited appeal to workers in Great Britain and in the United States. There is also a very full account of the Niggli norm, devised to supersede the Clark-Iddings-Pirsson-Washington norm, the disadvantage of which is that the standard minerals used as a basis of calculation rarely correspond completely with the actual mineral composition, or mode, of the rock. The Niggli equivalent-norm has the advantage that phases such as the amphiboles and the micas can be

represented in the calculations when they are present, but it would be a mistake to expect, even using this method, any really exact correspondence between norm and mode. Indeed, the description of this book as a "Monograph in the Field of Exact Science" is, in the reviewer's opinion, scarcely justifiable when the persistent inaccuracy of the method, and of even the best of chemical analyses of rocks, revealed by the international investigations of the past ten years, is recalled. Many petrographers now doubt whether it is proper to base elaborate calculations or classifications on such a shaky foundation. However, for those who still enjoy this exercise, here is a work after their own hearts. The new tables of molecular percentages included as an appendix are probably the best so far produced, and there is a wealth of illustration of graphical representation of the results of the calculations, for example, in triangular plots.

The author rightly claims priority for 'petrochemical' as a term to cover the chemistry of rocks and looks askance at the increasing use of the term to describe chemicals derived from petroleum. It might be suggested that the latter usage is now so widespread that it would be advisable to abandon petrochemical as a term of geology, and leave it to the chemical engineer.

K. C. DUNHAM

GEOLOGICAL WAYS AND BY-WAYS

Principles of Geology

By James Gilluly, A. C. Waters and A. O. Woodford. Second edition. (Series of Geological Texts.) Pp. viii+534. (San Francisco: W. H. Freeman and Company; London: Bailey Bros. and Swinfen, Ltd., 1959.) 7.50 dollars; 64*s*.

"PRINCIPLES OF GEOLOGY" appeared in 1952 when it was welcomed as an original and stimulating book. Clear style, remarkably little jargon and arresting illustrations were obvious virtues. Now, after seven years, when the first edition has proved useful to teachers and taught alike, the second edition has appeared, printed on a larger page, setting off figures and plates advantageously. The sequence of the chapters has been logically rearranged with a modicum of rewriting to incorporate some recent work and to expand the reviews provided on certain topics. The authors have retained their approach of furnishing short sketches of the people, like Nicholas Demarest, for example, involved in making geological discoveries, or in the controversies arising from them. The principle of uniformitarianism is sustained throughout, although some of the extraordinary incidents described as occurring in storms and floods supply live ammunition for the neo-catastrophists.

The selection of examples of geological phenomena fulfils the condition that "all the world's a stage", the Old World and the New, continents and oceans alike. Thus an earthquake, landslide and turbidity current intimately related to one another are demonstrated from the Grand Banks in 1929; the quiet sinking of a large region shown by a swamped river system in Indonesia, while building-stones in Glasgow's houses are used as evidence that deserts like those in present-day Nevada once existed where now flows the Clyde.

To me the locating of Funafati as "not far from Tarawa of World War II fame" is a case of the cart before the horse. In the new grouping sedimentary rocks and the environments of deposition get a chapter to themselves, but we "go out through that same door where in we went" in that the origin of dolomite is still mysterious. A later chapter commences with an account of the Lisbon earthquake of 1755, leads downwards through sial and sima to the Mohorovicic discontinuity into the mantle until it comes to the core of the earth, stuffed, as formerly, with question marks.

The discussion of mountains is excellently done and covers some familiar ground, but this is so vividly described that it leaves no doubt what the writers mean or where they stand in the realm of Alpine theories. Two points are of special interest. The first is the brief revised account of the "Basin Ranges" in the south-western United States. The individual ranges often have diverse and complicated structures not clearly related to any discernible geosyncline. Each one stands apart from its neighbours and is bounded by normal faults. The second is the comparison of the river-carried deposits of the Bramaputra and Irrawaddy respectively, thus presenting the idea also advocated by Kuenen[1] that substantial filling of a geosyncline may be accomplished along its trend and need not necessarily originate from its flanks.

It is a surprise to find a book of this character with so little to say about rift valleys and the recently described intriguing long straight fracture zones in the eastern Pacific, but perhaps something has to be held in reserve against a third edition. Recalling the scope of an ancient text-book like G. A. J. Cole's "Aids in Practical Geology", it is odd that the two geological handmaids, mineralogy and petrology, have each an appendix devoted to them but palæontology is omitted. Nevertheless, here is a book which all geologists will read with profit and enjoyment, and there will be few whom it does not caress or jolt into having to think.

J. V. HARRISON

[1] Kuenen, Ph. H., *Kon. Ned. Geol. Mijnb. Gen., Geol. Ser.*, **18**, 189 (1957).

GLOSSARY OF GEOLOGICAL TERMS

Geological Nomenclature (English–Dutch–French–German)

Edited by A.A.G. Schieferdecker. (Royal Geological and Mining Society of the Netherlands.) Pp. xvi+523. (Gorinchem: J. Noorduijn en Zoon, N.V., 1959.) 45 guilders.

IT is now thirty years since the Royal Geological and Mining Society of the Netherlands published a glossary of geological terms in the Dutch language, with English, French and German equivalents. The work noticed here is an entirely new production sponsored by this Society, and prepared by a team of collaborators of several nationalities. It has become necessary as a consequence of the progress of geological and closely allied sciences in the interval; which has led to the introduction of new concepts, new terms and new methods of carrying out geological investigations. Furthermore, and this is of particular interest to English-speaking geologists, because, in the opinion of the sponsors, the English language has become increasingly dominant in geological literature, the new edition has been prepared in English. Thus, the introductory matter and table of

contents are in this language, and the terms and phrases are given first and defined in English. These are followed by their Dutch, French and German equivalents.

The glossary contains 5,489 entries, and is arranged by subjects, there being eleven main divisions. Each of these is again divided, sometimes into as many as ten or eleven subdivisions, and the latter are again divided into smaller subject groups. Such an arrangement was no doubt essential in preparing the glossary, since the various subdivisions have been compiled by a large number of specialist collaborators but it does not make for ease of reference. This difficulty has been overcome by numbering consecutively all the entries, and their inclusion in a single four-language alphabetical index in which the reference to any particular term is by number, whichever language is used in consulting the index. Cross-reference from index to text can thus be made rapidly.

The principal divisions cover general and physical geology; geomorphology; sedimentation; stratigraphy; tectonics; geophysics; orogeny; vulcanology; petrology of igneous and sedimentary rocks; and mineral deposits. Crystallographic terms and the names of minerals, rocks and stratigraphical formations have been omitted from this edition; and palæontological terms are not included. It is a little surprising that among the list of collaborators there are few who may be supposed to have English as their mother tongue; but this omission is seldom apparent in the text and, where noticeable, without serious results. In choosing terms for inclusion in the glossary the editor has cast his net widely, and both glossary and index appear to have been compiled with much care. There is no doubt the book will form a valuable addition to geological, geographical and engineering libraries. Welcome as this new glossary is, in view of the very large amount of geological literature now appearing in the Russian language, often without adequate summaries in western European languages, the preparation of a supplement of Russian geological terms, in which the same index figures could be used, would be an extremely useful compilation. V. A. Eyles

LOW-ENERGY NUCLEAR PHYSICS

Proceedings of the International Conference on Nuclear Physics

Low-Energy Nuclear Interactions and Nuclear Structure, Paris, 7–12th July, 1958. Presented by Mme. P. Gugenberger. Pp. v+950. (London: Crosby Lockwood and Son, Ltd., 1959.) 140*s*. net.

THE international meeting of nuclear physicists held in Paris during July 1958 yielded the conference report under review, dealing essentially with low-energy nuclear physics. The conference and the preparation of the report (carried out by Mme. P. Gugenberger) were made possible financially by the United Nations Educational, Scientific and Cultural Organization and the International Union of Pure and Applied Physics, augmented by various other public and private sources. The volume of 1,600 pages reflects in its structure the new style of conference: specialist rapporteurs present the relevant contributions offered by members of the conference as survey papers, thus producing a well-knit whole out of a number of components. This survey is printed verbatim as are the discussion remarks following the rapporteurs presentations (325 pages). The rest of the volume contains the text of the communications, with an author index (612 pages).

My personal reaction to this volume is one of delight. The text gives the reader the impression of being present at the meeting, and the discussion produces a lively atmosphere through argument and counter-argument; as a result one can learn much about the subject with considerably less effort of will than from the original papers. Naturally, the rapporteur has already spent some effort in digesting the contents of a bunch of scientific papers. It seems clear that this type of conference and its reporting methods are here to stay. It is more stimulating and more informative than the string of 10-minute talks with which one is familiar from Physical Society meetings.

The conference was opened by Prof. F. Joliot on July 7, 1958 (five weeks before his death) and closed with an illuminating summary by Prof. L. Rosenfeld. The various sections deal with the following topics: (*a*) Elastic Scattering of Neutrons (H. H. Barschall); Charged Particles (A. E. Glassgold). (*b*) Scattering and Nuclear Forces: Scattering by Electrons (R. Hofstadter); Analysis of *p*–*p* Scattering below 40 MeV. (M. H. McGregor). (*c*) Direct Interaction: Theory (C. T. De Dominicis); Deuteron Stripping (G. R. Satchler); Experimental (B. L. Cohen). (*d*) Heavy Ions (A. Zucker). (*e*) Photonuclear Reactions (J. S. Levinger). (*f*) The Independent Particle Model and its Connexion with the Collective Model (A. M. Lane, S. A. Moszkowski). (*g*) The Collective Model (A. Bohr); Coulomb Excitation (F. K. McGowan). (*h*) Structure of Nuclear Matter (C. Bloch). (*i*) Weak Interactions: Theory and Experimental Results (R. Nataf).

It is regretted that the text of the Russian contributions was not received in time for incorporation in the report.

Mme. P. Gugenberger and the publishers are to be congratulated on producing this fine conference volume; they both deserve the gratitude of the nuclear physicists. E. Bretscher

ROCKET PROPELLANTS

Rocket Propellants

By Francis A. Warren. Pp. ix+218. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1958.) 52*s*. net.

THIS book is designed to provide both the technical reader and the newcomer with basic information on the propellants used in modern rockets. The author has been directly associated with the development of propellants and rockets since 1942 and is well qualified to write a book on this topic. There are chapters dealing with the different types of propellants (both solid and liquid), propellant ingredients, the manufacture of solid propellants, performance and burning characteristics, the more important design features in both solid and liquid motors, safety, quality control and the future of rocket propellants. For a book of its size all these subjects are dealt with very adequately; the matter is clearly presented and supported by a useful selection of photographs, line drawings and graphs. There is surprisingly good coverage of the possible combinations of fuels and oxidants, and in the early

chapters one frequently encounters novel items of information and 'know-how' not previously seen in publications of this kind.

The bibliography quoted is extensive but, perhaps inevitably, predominantly American. During the Second World War, and particularly in its early stages, the Americans were supplied with a great deal of information from Great Britain about the design and manufacture of small solid-propellant rocket motors. It is always a little disappointing that British workers who have played a conspicuous part in these developments are not as well known as they deserve to be, mainly because they have been associated with material which only slowly finds its way into the 'open' literature.

While the book is very readable and informative, there are some omissions. For example, in the section dealing with composite propellants there is no mention of 'plastic propellant', a wholly British concept which started during the War. This propellant has a good performance and possesses exceptional chemical stability. Its main ingredients are ammonium perchlorate (the oxidant) and a hydrocarbon binder (the fuel); these are mixed together to form a stiff 'putty' which can then be pressed into the desired shape in a rocket tube. Plastic propellant is used in a range of fairly large motors, notably in the *Skylark* rocket, which has been employed in the upper atmosphere research firings in Australia.

In the discussion on "Ballistic Agents", minor ingredients used to modify the burning characteristics of propellants, it is mentioned that potassium sulphate was originally used to reduce the flash and smoke in guns. This latter point, that is to say, smoke reduction, is incorrect, since any inorganic additive must aggravate the smoke problem. However, the book is well edited and no slips of real significance have been noted.

The final chapter deals with "The Future of Propellants". This outlines very clearly the possibility of developing propulsion systems of greatly enhanced performance by various applications of nuclear power.

The author is to be commended on producing a very readable book which contains a useful blend of basic information and technology. It can be recommended to those seeking a good introduction to all aspects of rocket propellants. W. B. Littler

AN EASY GUIDE TO RADIO ASTRONOMY

Radio Studies of the Universe

By Dr. R. D. Davies and Dr. H. P. Palmer. Pp. viii+200+14 plates. (London: Routledge and Kegan Paul, Ltd., 1959.) 25*s*. net.

As the joint authors of this book are two experienced radio astronomers working at the Jodrell Bank Experimental Station, the authoritative nature of the material is assured. The book is intended for the non-specialist, and does not assume any appreciable previous knowledge of either radio or astronomy. It can be recommended as a useful and informative outline of the results achieved in all aspects of this progressive new branch of scientific activity.

The book begins with a brief outline of optical astronomy; then a description of radio methods is followed by an account of the various sources of radio emission beyond and within the Galaxy including the Sun and solar system. Subsequent chapters deal with the application of radar to the study of meteors, auroræ, the Moon and planets, and the contribution of radio-astronomical methods to the study of the Earth's upper atmosphere. There are a useful glossary and a selected list of references. The book is printed in large type and illustrated with plates and diagrams.

The writing of books of this class, often described as 'semi-popular', presents the problem of conveying a correct meaning without encumbering the reader with the detailed concepts of rigorous treatment. In this elementary survey of radio astronomy, the authors have for the most part succeeded well in this respect. In some places a slight amplification would have been helpful. It would have been worth attempting to show, possibly in a further appendix, how the expressions for the beam-width of a radio telescope and for the lobes of an interferometer pattern are derived, as these involve only elementary ideas of wave motion. The significance of band-width in radio noise reception could also have been more adequately covered.

Only in a few instances could one feel more particularly critical of the authors' approach. For example, a statement that the amount of radiation received by an aerial is proportional to its area is followed by a discussion of linear aerials, and it is not made clear what 'areas' they possess. Later, radar echoing properties of objects are again loosely identified with their 'areas'. A different type of misleading impression arising from inadequate explanation occurs, for example, in the description of visual solar activity, where a statement ". . . when the outer edge of the Sun is viewed through a telescope . . ." neither suggests the necessary precautions nor the special technique involved in making optical solar observations. It would not, however, do justice to the book to dwell unduly on a few defects of detail. The book as a whole provides a simple and comprehensive guide to radio astronomy. J. S. Hey

PROBLEMS OF SPACE FLIGHT

Vistas in Astronautics

Vol. 2. Edited by Morton Alperin and Hollingsworth F. Gregory. Second Annual Astronautics Symposium sponsored by Air Force Office of Scientific Research, and Institute of Aeronautical Sciences. (International Series of Monographs on Aeronautical Sciences and Space Flight. Division 7: Astronautics, Vol. 2.) Pp. x+318. (London and New York: Pergamon Press, 1959.) 105*s*. net.

The second Astronautics Symposium organized by the U.S. Air Force Office of Scientific Research was held at Denver, Colorado, in April 1958, and this volume records the proceedings. The papers can conveniently be divided into four groups. The first group is concerned mainly with scientific experiments in space, and includes a concise survey by S. F. Singer of the outstanding scientific problems in the region out to the Moon's distance. The second and largest group deals with the propulsion, orbits, control and guidance of space vehicles. There is a significant paper by A. Ferri and others, who conclude that the use of turbo-jet and ram-jet engines in the launching

missiles for space vehicles, up to speeds of say Mach 4, might considerably reduce the weight at launch and the rocket thrust required. Another notable contribution comes from J. H. Laning, jun., and others, who describe a design study for a vehicle to go near Mars, to photograph it, and to return.

The third group of papers records a discussion panel on the question "What use is man in space?" The answer given by almost all the speakers was: "not much use at all". But the U.S. Air Force chairman stoutly resisted this undermining of the Symposium's *raison d'être* by saying that man will, nevertheless, go into space.

The fourth and most controversial group of papers is concerned with the Moon. First, T. Gold argues persuasively that the Moon's surface is deeply covered in dust: "the top few feet may well be extremely loose and more treacherous than quicksand". Then F. L. Whipple, just as persuasive, contends that the dust must cement "into a weak, porous matrix" under the bombardment of meteorites, corpuscular radiation, etc. Finally comes G. P. Kuiper, whose paper is the most striking in the book, since it contains twenty-three magnificent photographs of the Moon, mostly full-page: after surveying the lunar topography in detail, Dr. Kuiper finds "overwhelming evidence that the traditional view that the mare floors are *lava fields* is correct"—a rebuff for the dust-men.

These technical papers, which take up most of the book, form a valuable record; but the same cannot be said for the introductory material, which often sounds too nationalistic a note. Nor is the editing perfect: for example, a three-line footnote on p. 139 has somehow escaped the deletion it obviously deserves, and the grouping of the contributions is not entirely logical, since the solitary paper on "Space Navigation" appears in the section entitled "Control and Propulsion . . .", and not in the section on "Departure, Space Navigation and Re-entry", which would seem to be its proper home.

D. G. King-Hele

PLANETARY DYNAMICS

Celestial Mechanics

By E. Finlay-Freundlich. Pp. viii+150. (London and New York: Pergamon Press, 1958.) 50*s*. net.

Stability in Celestial Mechanics

By Prof. Yusuke Hagihara. (Jubilee Publication in Commemoration of the Sixtieth Birthday of Prof. Yusuke Hagihara, by his Friends and Pupils.) Pp. x+106. (Tokyo: Kasai Publishing and Printing Co., 1957.) n.p.

TEN years ago it was commonly thought by many astronomers, most mathematicians and almost all physicists that celestial mechanics was a dead subject of historical interest, that it had been worked out, and that it was unlikely in the future to yield new results of fundamental importance. The advent of artificial satellites has led to a re-awakened interest in many of the problems of celestial mechanics. It is therefore quite appropriate that new text-books should be written not only to cater for the new demand but also so that those unfamiliar with the subject may become acquainted with the vast body of knowledge which exists and of which they might otherwise remain ignorant.

The two books under review are of quite different kinds. Prof. Freundlich's book is a self-contained introduction to the subject. After a brief introductory chapter, the *n*-body problem is discussed, including Lagrange's solutions to the three-body problem, the singularities of the three-body problem and periodic solutions in the neighbourhood of the points of libration. This is followed by an outline of the application of the Hamilton-Jacobi theory, a discussion of the principles underlying perturbation theory, and several discussions on the problems of periodic motions. The book ends with chapters on the two-body problem for extended deformable bodies and on the motion of the apsidal line in relativistic mechanics.

The most surprising feature of the book is the discussion in a relatively elementary way of so many advanced topics, and this is to be commended. It is unfortunate, however, that space was not found for a rather more detailed discussion of some of the basic problems. For example, many university mathematical courses in dynamics end at Lagrange's equations, and proofs of Hamilton's equations and the Hamilton-Jacobi Theorem (without the use of contact transformations) would have added to the value of the book. Also a course on celestial mechanics can scarcely be considered complete if it does not include the equations for the variation of the elements of an orbit. This is, after all, the feature of celestial mechanics of most interest for artificial satellites. Those who, like myself, are frequently charged with the duty of giving formal lecture courses in celestial mechanics, will be grateful to Prof. Freundlich for providing in this text a useful survey of the subject, but they will of necessity supplement this survey with selections from more advanced books to fill the more obvious lacunæ.

Prof. Hagihara's book was published by his friends and pupils to celebrate his sixtieth birthday. He has attempted to summarize the present situation in the efforts towards solving the very difficult problem of the stability of the solar system. His book ranges widely over many difficult aspects of celestial mechanics, and, by omitting or outlining proofs, he succeeds in giving in a short space an exhaustive survey. He discusses the results of the most advanced research work more completely than any existing text-book or review, and gives comprehensive bibliographies. His book is a land-mark in celestial mechanics.

Neither of the books under review contains any discussion of the numerical problems of celestial mechanics, and it is to be hoped that someone will be stimulated into filling this gap in the literature.

R. H. Garstang

STEVIN'S MATHEMATICAL WORKS

The Principal Works of Simon Stevin

Edited by Prof. D. J. Struik. Vol. 2A: Mathematics. Pp. v+1–456. Vol. 2B: Mathematics. Pp. iii+457–976. (Amsterdam: Swets and Zeitlinger, 1958.) n.p.

THESE two volumes comprise Stevin's principal mathematical works. The first begins with an account of his little known "Tables of Interest" (1582). In a period of rapid commercial expansion,

when even the ordinary arithmetical operations still presented difficulty, the computation of interest called for no little skill, and so the appearance of Stevin's "Tables" must have proved a boon to the great banking houses, such as those of Lyons and Antwerp. Many readers will be interested to trace, with the help which Prof. D. J. Struik has abundantly provided, the origins and the growth of such tables; they will be grateful for the translation and the copious references provided.

The "Problemata Geometrica" deals with the division of polygons into parts having a given ratio. The *regula falsi*, a favourite device of the mathematicians of the Middle Ages, is freely used. Then follows a study of the regular and semi-regular polyhedra and the construction of polyhedra similar to a given polyhedron. Stevin follows closely in the footsteps of Euclid and Archimedes without removing many of their obscurities. The ample footnotes provided have at least succeeded in making a difficult subject attractive.

Probably the most interesting section of Stevin's work is his exposition of the principles underlying the use of decimal fractions. Prof. Struik's judgment: "It is safe to assume that Stevin's work contributed to the growing popularity without ascribing the success exclusively to him" (p. 377), is very fair, and it is supported by an exhaustive list of references to pioneers in the development of this branch of arithmetic. The facsimile reproduction of "La Disme", and its side-by-side translation, cannot but be accorded a warm welcome from those who have not access to Stevin's original tract. Nevertheless, it is extremely doubtful if the decimal system of writing fractions would have achieved such a wide popularity had it remained in the clumsy notation which Stevin adopted. A number of writers of the period who employed decimal fractions, either with or without Stevin's notation, follow the exposition. The omission of the names of Oughtred and Wallis is a little surprising. The former, in his "Clavis Mathematicæ", adopted a much more convenient notation. "Decimal parts are written in the same line with integers . . . They take their denomination from the place of their last figure, as 0/5 are five-tenths, 0/56 are fifty-six hundredths". Wallis, in his "Mathesis Universalis" (1657) followed Oughtred's notation, but in his "Algebra", written nearly thirty years later he sometimes uses the full stop, as 3.14159, and sometimes the comma, as 12,756.

The main merit of Stevin's "L'Arithmétique" is the systematic way in which he discusses operations with rational, irrational, and algebraic numbers, and the theory of equations of the second, third and fourth degrees. Here the editor shows an intimate knowledge of the steps which led to the solution of algebraic equations during the fifteenth and sixteenth centuries, and he has placed the reader very much in his debt by his exhaustive bibliography. He rightly criticises Stevin's interpretation of powers higher than the cube as "a clumsy procedure". Not everyone, however will agree with his view that "the way out towards spaces of higher dimensions only appeared in the nineteenth century". For did not Descartes ("La Géométrie", 1637) point the way when he threw aside the dimensional restrictions of earlier writers (for example, Vieta) and divorced such expressions as a^2, b^3, and higher powers from reference to physical quantity? These are nothing more than the terms of a continued progression, the first term being unity. They should not, therefore, have caused any embarrassment in explaining powers higher than the cube. In this section of the work no little skill is shown in the selection for reproduction of those passages which best illustrate the sixteenth century approach to the solution of equations.

Readers will welcome the section dealing with Stevin's contribution to trigonometry, which is preceded by a brief account of the development of the subject from Ptolemy. The chief feature of this, in Prof. Struik's judgment, is the clarity of its exposition. This view will be readily accepted. But there was rather more in it than this. It was only a few years prior to the appearance of this work that trigonometry had emerged as an independent science. Stevin's contribution gave a great impulse to a movement which was already rapidly gathering strength.

Stevin's work on perspective is probably among the most original of all his work. It was written in the vernacular, and this may well be a reason why it has not become widely known outside the Low Countries. Prof. Struik's translation does much towards removing this limitation.

The appearance of these two volumes goes a long way towards filling a gap in our acquaintance with Stevin's mathematical work. They illustrate the vast range of his contributions to the subject. His gifts, outstanding as they were, have been overshadowed by those of his great contemporaries and successors. For Stevin lived in an age of intellectual giants—Vieta (1540–1603), Galileo (1564–1642), Kepler (1571–1630), and he was followed by men no less distinguished—Wallis (1616–1703), Fermat (1601–1665), Pascal (1623–65), Descartes (1596–1650)—to name but few. This, together with the fact that much of it was written in Flemish, may be a reason why his work has hitherto not received at the hands of the historian of science the recognition which is its due. Prof. Struik has gone a long way to remedy this situation, and the appearance of later volumes will be awaited with considerable interest.

The only feature open to serious criticism is the index, which, for a work of nearly a thousand pages, is condensed into a few columns. Would it be too much to hope that, in subsequent volumes, Prof. Struik will devote as much care to the compilation of a really helpful index as he has done to the rest of the work?

J. F. Scott

GÖDEL'S THEOREM

Gödel's Proof

By Ernest Nagel and James R. Newman. Pp. ix+118. (London: Routledge and Kegan Paul, Ltd., 1959.) 12*s.* 6*d.* net.

FROM time to time a little masterpiece of exegesis appears in the field of mathematics and physics: this little manual is certainly such a one. It deserves a place with Sylvanus Thompson's "Calculus Made Easy", and Biggs's "Wave Mechanics". But in a sense it is better than either of them, in that it manages to convey the spirit of the genius of Kurt Gödel, and to show his achievement of 1931 (at which time he was twenty-five years old) as at least comparable with Euclid's, when he selected the particular form which he did to enunciate the parallel postulate, realizing at the same time that

proof was needed, but impossible to supply. It is curious that, as in Gödel's theorem, it is in these declarations of impotence that mathematicians sometimes reach their zenith. In demonstrating, and accepting, the impossible, mankind (paradoxically) breasts its summit.

Throughout history, the axiomatic method has gained favour, and advanced from strength to strength. Seen in full vigour in Euclid's geometry, it appears again for mechanics in the hands of Archimedes. Centuries later, something akin ran in the mind of Descartes, and in our own century (1908) we find it in the *Axiomatik* of Carathéodory's thermodynamics. What more fitting for it to support the great structure of arithmetic, and the aesthetic satisfaction of David Hilbert's systematic foundations ? Yet that is just what it has failed to do, and what Gödel showed it fundamentally incapable of doing. It is nothing less than that which constituted the core of his original paper, with the forbidding title "On Formally Undecidable Propositions of Principia Mathematica and Related Systems". All this germinated in the mind of the young member of the Vienna Circle. When events shattered that distinguished group, Princeton came to the rescue, and Harvard acclaimed Kurt Gödel at his true stature.

The authors of the present book begin by discussing the problem and absolute proofs of consistency, giving an example wherein such a proof is successful. This entails, *en route*, the systematic codification of formal logic. A reader with some little competence in the sentential and existential calculus will have no particular difficulty in following the train of thought thus far. Then comes the idea of mapping, and its use in mathematics. It is exactly here that the power of Gödel is so remarkable. We are familiar with the processes of projective geometry, or those involving the theorem of Pappus, wherein an abstract structure of relations in a domain (A) can be mirrored as holding in another domain (B). (In this particular case the transform is between points and lines.) What Gödel did was to map statements 'about' arithmetic as expressions 'in' arithmetic. In other words, he managed to project the meta-mathematics of arithmetic upon arithmetic itself. This method amounts in effect to making meaningful statements about a formalized mathematical system ; it says something about mathematics, but plainly not belonging to it. Meta-language and meta-science sometimes present difficulties to the British way of thinking. Perhaps a very crude analogy would be the distinction between history and historiography, which is well accepted among scholars.

The end-result of Gödel's achievement is that arithmetic is incomplete. The way in which this remarkable conclusion is reached is by proving that there is at least one mathematical truth which cannot be said to follow from the axioms, and yet can be established meta-mathematically from outside.

We are thus faced with severe limitations in the whole axiomatic method itself, and everything built upon it. One cannot specify once for all a fixed set of axioms to shore up and bear the whole load.

There is, as the authors point out in a significant footnote (pp. 99–100), a throw-back to a type of Platonic realism. Gödel would seem to accept the existence of classes and concepts as real objects whether in fact we have 'realized' them or not. This may have wide repercussions, for it may prove to be in line with Heisenberg's primordial matter (after the manner of Anaximander), which he considers may be needed to extricate the quantum theory from its present philosophical confusion. Supposedly, such an entity would exist independently of our thoughts about it.

For what is little more than an essay on a vast subject, the writers have done astonishingly well. The proof-reading must have been as near faultless as human frailty can accomplish, since a minor misprint in such a strange land would lead many a careful inquirer to despair. To make Gödel's theorem more accessible is something supremely worth while, and this book is the way to do it.

F. I. G. Rawlins

ORGANIZATION AND METHODS

Organization and Methods

A Service to Management. Edited by G. E. Milward. Pp. xxxii + 408 + 4 plates. (London : Macmillan and Co., Ltd. ; New York : St. Martin's Press, Inc., 1959.) 63*s*. net.

THIS is essentially a practical book and gives the essence of the experience in organization and methods work of nine large commercial companies. Mr. Milward has done an excellent job in producing such a readable volume and one which does not show evidence of its rather mixed parentage. As one completely untrained in office management, yet who has had to accept responsibility for the many 'administrative' aspects of a large scientific institution, I can testify to the value of organization and methods procedures as described in this book in simplifying and often in reducing the ever-increasing paper work.

The book is concerned essentially with the practice of "Organization and Methods", the types of people required to carry out its procedures, their training and methods of working. It does not ignore the human factors which form such an important part in the operation of any organization. Its range is from the setting-up of an organization and methods department to information about types of office machines and their efficient use, and even to some matters of detail such as the optimum size for an office desk. In these days, when there is such a plethora of office machines and office systems on offer, it is extremely valuable to have, in convenient form, the product of the experience of leading companies.

A feature of the book which is claimed to be unique is a chart on the field of office machinery. This sets out diagrammatically the seven basic clerical operations and the machines which carry out or assist them, while the pros and cons of mechanization are discussed in the text. There is much in this book of interest and value not only to the managers of large commercial offices but also to those who have to incorporate in their organizations or institutions some efficient system of collection of data, record-keeping, ordering, etc. The index does not do justice to the book—especially one on this subject. For example, 'Pros and cons of mechanization' is indexed under '*P*', with no reference under '*M*' ; 'Glossary of arithmetical terms' is under '*G*', with no reference under '*A*', and so on.

E. S. Hiscocks

SHORT REVIEWS

Alan M. Turing

By Sara Turing. Pp. xiv+157+7 plates. (Cambridge: W. Heffer and Son, Ltd., 1959.) 21*s*. net.

FRIENDS and acquaintances of the late Dr. A. M. Turing, as also a much wider circle who only knew him through his published work, will welcome this succinct and timely biography by his mother, Mrs. Sara Turing. Alan M. Turing, who died in tragic circumstances in 1954, in his forty-second year, had already gained wide recognition for his work in mathematics, computing theory and machine design, and for a novel physico-chemical theory of morphogenesis; and, on the evidence, he was still on the flood-tide of even more remarkable achievements. Unfortunately, this was not to be.

Now, in this readable volume, presented with admirable detachment and singularly unmarred by the excess of sympathy which might well have crept in, we have an outline sketch of a very remarkable, and original, if sometimes wayward personality, direct, friendly, whimsical, and generous to a degree. Talent may be said to be the mainstay of academic life; but his contemporaries recognized that Turing had that very much rarer quality—genius. How much genius it is not possible to assess at this stage. Hence the value of this biographical memoir; for as Lyn Irvine (Mrs. M. H. A. Newman) has indicated in a percipient foreword, this is a source-book for future biographers, especially those who are concerned with the nature and manifestation of genius.

A Source Book in Greek Science

By Prof. Morris R. Cohen and Dr. I. E. Drabkin. Second printing, with corrections. (Source Books in the History of the Sciences.) Pp. xxi+581. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1958.) 60*s*. net.

IT is interesting to see that this well-known work, which first appeared in 1948 from the McGraw-Hill Book Co., has been taken over by the Harvard University Press and is distributed in Britain by the Oxford University Press; and it is to be hoped that the other volumes in this excellent series are to be made similarly available in the near future. The great value of the book has always lain in its making immediately available, to students of the history of science and to other interested readers, English versions of Greek scientific literature that they would otherwise have to seek through many volumes in a library of considerable size; and it has another importance as a corrective of the partial and narrow view that scientific thought began in the seventeenth century. These six hundred pages of extracts on mathematics, astronomy, geography, physics, chemistry, technology, geology, meteorology, biology, medicine, physiology and psychology, with easy reference through a detailed table of contents, place at the reader's disposal a wealth of scientific literature and information that ranges through ten centuries. The comments connecting the extracts and the notes on the extracts have been well prepared, and the illustrations are suitably chosen.

Two impressions of Greek science that the reader gets from a critical survey of these extracts are very clear, namely, the preponderance of mathematics and the lack of understanding of experimental science. One could say with confidence not so long ago that in these joint respects Greek science differed much from that of our own time, but to-day one may be allowed to wonder whether there are not some scientific activities that have recently resumed these ancient characteristics.

Robert Boyle

Father of Chemistry. By Dr. Roger Pilkington. Pp. 179. (London: John Murray (Publishers), Ltd., 1959.) 18*s*. net.

ALL scientists know Boyle's Law, and many are aware of Boyle's work on combustion and respiration and his critical approach to chemical theory. But how many know that the author of "The Sceptical Chymist" wrote a religious romance and financed the translation of the Bible into the language of the North American Indians?

Dr. Roger Pilkington gives a balanced account of all aspects of this remarkable man's life and character. Boyle's chemical heritage is well described, and his scientific work is described as fully as possible in a short book, but more might have been said about the work and opinions of his contemporaries and the consequences of his discoveries and theories. This would have been particularly useful to readers unfamiliar with the history of science. If such a chapter can be added to a future edition it will enhance the value of a well-written book that can be read with profit by all who are interested in the men behind the scientific laws and theories.

W. A. SMEATON

Structure and Function of Genetic Elements

Report of Symposium held June 1–3, 1959. (Brookhaven Symposia in Biology, No. 12.) Pp. v+187. (Upton, New York: Brookhaven National Laboratory, 1959. Available from Office of Technical Services, Department of Commerce, Washington, 25.) 2 dollars.

THE Brookhaven symposia on biology are sponsored by the Department of Biology of the Brookhaven National Laboratory. The twelfth symposium was held during June 1–3, 1959, and was devoted to the topic of the structure and function of genetic elements. The object of the symposium was to bring together the several points of view of the physical chemist, the biochemist, the geneticist, the cytologist, and the cytochemist. There are fourteen papers in all, covering these disciplines. All are valuable and important, and almost as valuable as the papers are the full reports of discussions and comments by the participants.

The subjects dealt with are: (1) Structural aspects of nucleic acids; (2) Biochemical activities of nucleic acids; (3) Genes; (4) Genetic transfers by viruses; (5) Structure and duplication of chromosomes; and (6) Nuclear-cytoplasmic relationships.

The results presented at this symposium may be compared with those of eight years ago at the fourth Brookhaven symposium, on a similar theme, the chemistry and physiology of the nucleus. It is clear that considerable advances have been made in our knowledge of the structure and function of the genetic elements. This is in some part due to improved techniques in the various areas of study. Autoradiography is, for example, extensively employed to help solve the problem of how chromosomes duplicate themselves.

Among the most valuable contributions are those of a general nature, for example, those concerning the present position of the coding problem (Crick), the present status of the adaptor hypothesis (Hoagland) and a comparative view of the chromosome (Steffenson).

Light touches are provided by Crick—"Hinshelwood once suggested a code dependent on the sugar but I never understood what he meant", and Zamenhof—"Could it be that all these things are not gene determined? Or could it be that there is some information also in the sugar, God forbid?"

S. C. Harland

Blindness in West Africa

By Prof. F. C. Rodger. Pp. xiv+262+1 plate+6 maps and 96 text figures. (London: H. K. Lewis and Co., Ltd., 1959. Published for the Royal Commonwealth Society for the Blind.) 70*s*. net.

In Great Britain there are about two certified blind persons in every 1,000 of the population. A report from thirty-nine Commonwealth and Colonial territories has given a figure of about eight blind per 1,000, with far the largest numbers in West Africa.

This book records the findings of a survey in Nigeria, North Ghana and the Cameroons, and Prof. Rodger, allowing for factors like visual standards, assesses the overall figure of blindness as about 1 per cent of the population with the figure much higher than this in North Ghana, where onchocerciasis, a generalized infestation by a fly-borne filarial worm, is very severe. The countries, the people and their eye diseases are all reported upon, and, while much is technical, Prof. Rodger has presented his material so that a lay person will find interest in it. Eye disease among children was especially investigated and considerable attention paid to nutritional standards. The report is objective and parts make gloomy reading, for much of the blindness arising from infection (purulent smallpox, syphilis, etc.) and malnutrition is preventable. Trachoma, the cause of the greatest number of blind, is now amenable to treatment, and may perhaps be eradicated before too long; but the elimination of filarial worm disease remains a problem to be solved.

The production of the book is good, though the illustrations vary a lot in quality.

R. C. Davenport

The Hand of Life

The Story of the Weizmann Institute. By Ritchie Calder. Pp. 78+65 plates. (London: Weidenfeld and Nicolson, 1959.) 30*s*. net.

In 1934 the Daniel Sieff Institute was established in the desert at Rehovoth, Israel, as a memorial to the son of Mr. and Mrs. Israel Sieff and the nephew of Sir Simon Marks. The memorial had been suggested by Dr. Chaim Weizmann, the distinguished chemist who became the first president of Israel. Ten years ago the Weizmann Institute was also founded at Rehovoth and, to mark both occasions, Ritchie Calder has produced a tribute worthy of the magnificent buildings and gardens which now flourish in a place where twenty-five years ago there stood nothing but sand. This handsome book describes some of the outstanding investigations which have been made at both Institutes and also contains a series of photographs which give a clear impression of what life is like for those who live and work at Rehovoth; their scientific investigations are a worthy memorial to Sieff and Weizmann.

Paths Across the Earth

By Lorus and Margery Milne. Pp. xi+216. (London: Cassell and Co., Ltd., 1959.) 16*s*. net.

It is unfortunate that the wrapper should tell us that the authors, two American zoologists, have "travelled together from the Arctic to the Equator to try to solve such problems", because they say little at first hand and nothing new. The book is in fact a popular account of the migratory movements of animals, presented in chapters devoted to general aspects or questions; New World examples naturally predominate. It should be interesting to readers coming fresh to the subject and willing to accept a degree of arbitrary simplification. There are, however, surprising omissions; for example, Kramer is not mentioned among seven authorities named in respect of bird navigation; there is no reference to the regular annual movements of some African antelopes—indeed almost an implication that such do not occur; and a section on echo-location contains, in that regard, only a vague statement about mice and none of the precise information available for bats, cetaceans and certain birds. There are also definite errors; for example, it is the reverse of true to say that ringing has shown that the majority of British native starlings do not remain throughout the year but migrate towards the Mediterranean; and it is not the case that the cattle egret has shown no recent range expansion in the Old World comparable with its spread to and in the Americas.

Landsborough Thomson

Handbook of Toxicology

Vol. 5: Fungicides. Analysis and Compilation by Everett F. Davis, Barbara L. Tuma and Lucy C. Lee. Edited by Dorothy S. Dittmer. Prepared under the direction of the Committee on the Handbook of Biological Data, Division of Biology and Agriculture, National Academy of Sciences—National Research Council. Pp. ix+242. (Philadelphia and London: W. B. Saunders Company, 1959.) 38*s*. 6*d*. net.

This volume lists 196 substances known to destroy fungi or to inhibit their growth and reproduction. For each the structural formula, physical and chemical properties, tests (*in vitro*, *in vivo* or both), toxicity to man and animals, and use are given. Authorities for this information are included in the bibliography of 326 titles, and patent numbers (United States and others) for 112 of the 196 substances are listed in Appendix i. Appendix ii lists 500 other substances, refers to references to them in the general bibliography, but gives no other information. This should be a useful reference work for those advising on the use of fungicides in industry and agriculture.

Agricultural Insects of East Africa

Compiled by R. H. Le Pelley. Pp. x+307. (Nairobi: East Africa High Commission, 1959.) 42*s*.

ENTOMOLOGISTS and agriculturalists in many tropical countries, particularly in Africa, have been greatly handicapped because they have not been able to refer to authoritative lists giving the names of insects recorded there. A great deal of the information required has been collected by Government entomologists, and has been buried in departmental files. Dr. Le Pelley has performed a useful service in bringing together in this book so many records of insects and mites associated with plants in Kenya, Uganda, Tanganyika and Zanzibar; workers here, in adjacent territories and even in other parts of tropical and sub-tropical Africa, will find the lists invaluable. Parasites, predators and stored products insects are included, with the original reference to the publication first giving their occurrence. A list like this cannot but be incomplete, as its author would be the first to point out; but he is to be sincerely congratulated on his success in including so many records others would not have unearthed.

The title, "Agricultural Insects of East Africa", may mislead. This book contains only a list of names of insects and plants. It does not give any descriptions of the animals, or of their importance in agriculture. It is a very valuable work as it stands, and it is perhaps unfortunate that the title does not make its nature more obvious.

KENNETH MELLANBY

A Laboratory and Field Manual of Ornithology

By Olin Sewall Pettingill, Jr. Third edition, second printing. Pp. viii+279. (Minneapolis: Burgess Publishing Company; London: Mayflower Publishing Co., Ltd., 1958.) 40*s*.

IN recent years ornithology has become increasingly respectable among contemporary sciences without losing its place as a source of casual interest and amusement. This status has been achieved to a large extent by improvements in standards of teaching as reflected in such books as this laboratory and field manual. In Britain it seems difficult to isolate ornithology as a special subject in the curricula of secondary schools and universities, and teaching is confined mainly to extra-mural environments. But in the United States, apparently, this difficulty is not felt to the same extent, for Prof. Pettingill's manual is based on notes for lectures at high schools and colleges. The text consists of explanatory material and directions for study, including lines of research for advanced students. Although retaining the form and structure of lecturer's notes (it is a photo-offset reproduction of typescript) it is a valuable source of useful information on most aspects of bird biology.

J. D. MACDONALD

The Buzzard

Text and Photographs by Frank Wenzel. Translated from the Danish by Reginald Spink. Pp. 86. (London: George Allen and Unwin, Ltd., 1959.) 35*s*. net.

THIS book from Denmark, written and illustrated by Frank Wenzel, is a fine example of bird photography. Its illustrations from photographs in colour and in black-and-white include many superb pictures, some of remarkable dramatic quality, for example the colour plate facing p. 80. This shows a buzzard balancing itself with extended wings held aloft on a swaying branch. The bird is silhouetted against a stormy sky with a dazzling sun gleaming from between the clouds. Another pleasing picture is the portrait of a buzzard facing p. 73. It shows a remarkably light-coloured bird in a green woodland setting and it reminds us how this species varies in colour and markings. A little farther on is a photograph of a very dark male, with plumage of deep sooty brown, indeed almost black.

The letterpress is comparatively slight; but it is based on first-hand observations, telling of the author's experiences among the buzzards of his native Denmark. He gives us many exciting descriptions of its woods, heaths and marshes. He tells how he built a hide in a tree from which he could see into a buzzard's nest in a neighbouring tree; he adds he thought it desirable to ensconce himself in it under cover of darkness, though to do so he had to walk through the night-time woods. "Moonlight makes everything change character," he says. "Things well known in daylight now appear quite unfamiliar. Tree trunks look like dark figures throwing long mysterious shadows in the undergrowth; harmless stumps are transformed into witches and ogres. The silence was broken over by the bog. There was a strange purring and whirring noise . . . it was the phantom nightjar filling the night with magic and mystery."

This volume would make a fine present for any young person with aspirations to use his camera in the portrayal of birds.

FRANCES PITT

Diseases of Farm Crops

By A. Beaumont. Pp. 128+48 photographs. (London: W. H. and L. Collingridge, Ltd., 1959.) 25*s*. net.

THE farmers and agricultural students for whom the author intends this companion volume to his "Diseases of Garden Plants" will be glad that it is written so clearly, with so few scientific terms and generously illustrated by photographs nearly all of which show what is intended. Readers better versed in plant pathology will recognize that most of the recent work is mentioned in summaries of the major diseases. The author is realistic about the importance of diseases, and the control measures necessary or practical; he emphasizes the effects of crop rotation and has added many cautionary notes born of his long experience as an advisory plant pathologist.

Because much of it is good, the weaker parts of the book stand out starkly. The arrangement of diseases under crops and the organs attacked makes reference easy, but leads to much repetition which could be avoided by tabulation or some grouping of closely related hosts. The too-simple section on naming and recognition of diseases, the many notes on rare fungi and, for example, the 15 references under marrow stem kale which contain little more than notes of frequency and cross-references, all make one wish the author had used this space to expand the sections on principles and major diseases.

J. M. HIRST

A Handbook of West African Flowers

By Harold N. Saunders. Pp. 124. (London: Oxford University Press, 1958.) 5*s*.

IT is not an easy task to select the commonest plants in an area, and the larger the area the more difficult it becomes. When the area is West Africa from Gambia to Nigeria, with a flora of several

thousand species, no selection within reasonable limits can hope to satisfy everybody everywhere. Nevertheless this attractive little book has courageously attempted the task, and the result is both creditable and useful. Within the limits of no more than 124 pages, 364 species are briefly described, and small, simple, clear illustrations of 120 of them are fitted in, four to a page. In addition there are a glossary and an ingenious numerical key, which the user after some practice should find helpful. A word of warning to the user to read *all* the choices in each column on pages 108 and 109, before deciding which one fits his plant best, is, I think, desirable. Hitherto there has been no pocket-book of West African flowers for the beginner. Now, for as little as five shillings, there is, and I hope that this book will start to perform its most valuable function of arousing interest and intelligent observation of what is growing round them among those people previously daunted by the learned and weighty scientific works, from which alone hitherto the name of the commonest West African roadside weed might be laboriously extracted.

J. P. M. Brenan

Miocene Floras of the Columbia Plateau

Part 1: Composition and Interpretation. By Ralph W. Chaney. Part 2: Systematic Considerations. By Ralph W. Chaney and Daniel I. Axelrod. Pp. viii+237+44 plates. (Publication No. 617.) (Washington, D.C.: Carnegie Institution of Washington, 1959.) 4.25 dollars; Cloth bound 4.75 dollars.

THIS excellent and comprehensive review of the Middle to Late Tertiary floras of the Western United States is for the most part a revision and synthesis of the research work carried out in the University of California by Emeritus Prof. Ralph Chaney and Dr. D. I. Axelrod, who have contributed many papers on this subject covering a period of more than forty years. The results of their research and that of earlier workers on the composition of the floras is brought together and from the result of this synthesis deductions are made as to the ecological and climatic features under which the floras existed. As an example, they find evidence that as a result of the increasing altitude of the Cascade Range during the Pliocene the conditions became drier and hotter and many constituent types of plant disappeared; whereas on the eastern sides of Asia and North America where the climates have remained moister these types still persist as constituents of the floras.

The second part of the review consists of what is in essence a catalogue raisonné of the fossils. These are well illustrated in the plates and there are also photographs of present-day vegetation in the United States for comparison with that of the Tertiary.

J. Walton

Memoirs of the Geological Survey of Great Britain

Palæontology, Vol. 4, Part 2: Fossil Plants of the Carboniferous Rocks of Great Britain. By Dr. Robert Crookall. Second edition. Pp. iv+85–216+plates 25–58. (London: H.M. Stationery Office, 1959.) 110*s*. net.

THE Geological Survey of Great Britain is publishing a complete account of the Coal-measure plants of Great Britain. This work represents the second part of the series on palæontology of which the first (pages 1–84) appeared in 1955. Like its predecessors it gives references exhaustively; descriptions are full and amply illustrated by photographs. The photographs indeed repay study with a fairly strong hand lens; structures 0·1 mm. apart can just be resolved. It is very like the memoirs being produced elsewhere on the same subject; as far as I can judge, the work is of equal completeness and quality, though the paper and margins may be less sumptuous. Like them, it seems written mainly for the geologist who has to correlate a rock by means of its fossil plants, and what is more, does it by the well-tried hand-lens methods. In the course of being complete, the present volume mentions microscopic work done by others, but does not add to it. If the botanically minded fossil botanist wants such information, he can determine his plant here, but then do all his own work. The treatment is conservative; the several subgenera used by some are rejected and though new species are made, their numbers are moderate. The only really adverse criticism to be made is at the very slow production. Kidston's Volume 1 of the series is dated 1923–25.

T. M. Harris

Strahlenbiologie

Grundlagen und Ergebnisse. Von Prof. Dr. Hedi Fritz-Niggli. Pp. xvi+379. (Stuttgart: Georg Thieme Verlag, 1959.) 65 D.M.

PROF. FRITZ-NIGGLI deserves congratulation for a masterly review, with 28 pages of references, of a subject that is difficult to make into a logically coherent whole. Though the reader is left feeling that the core of the subject, the cause of radiobiological damage, is as mysterious as ever, that is not the fault of the author. A further feeling, surprising and depressing, results from the author's painstaking historical research; this is that many of the facts that became familiar during the post-bomb wave of radiobiological research were just as familiar during the post-X-ray-radium wave at the beginning of the century. Good examples are the effects on blood cells and embryos, which were studied in amazing detail between 1903 and 1908.

A commendable feature of the book is that each branch of the subject is introduced with a short sketch of the basic knowledge needed to follow it; but the reader's education is rather peculiar. He is told that the atoms in a gram of hydrogen if placed end-to-end would stretch 76 times round the Earth's solar orbit, that proteins have large molecular weights and that nucleic acids are biologically important; but it is assumed that he knows how to distinguish a gynogenetic from an androgenetic haploid habrobracon. Fortunately his knowledge of histology is assumed to be imperfect; he is shown normal pictures for comparison with the abnormal. The book is attractively written and printed, with good illustrations and plenty of tables and ingenious but rather brain-twisting diagrams.

Die Aktivierte Essigsäure

Das Coenzym A und seine Acylderivate im Stoffwechsel der Zelle. Von Dr. Karl Decker. (Sammlung Chemischer und Chemisch-technischer Beiträge, Neue Folge, Nr. 57.) Pp. viii+300. (Stuttgart: Ferdinand Enke Verlag, 1959.) Ganzleinen 74.80 D.M.

THE index of this monograph might almost be that of a general text-book of biochemistry: so wide-spread are the functions of coenzyme *A*. It is difficult to realize that this coenzyme was discovered

only about ten years ago and that the mass of fundamental knowledge described in this book was mostly gained within that short time. Coenzyme *A* is a catalyst which is built up in the body from pantothenic acid, one of the vitamins of the B complex. It acts as a carrier of acid groups, particularly acetate; the acid, when combined as a thiol ester with the coenzyme, can take part in reactions which do not occur with the free acid. The acetyl derivative of coenzyme *A* ('activated acetic acid') is a key intermediate substance in the body, for it is on the direct pathway for the metabolism of carbohydrate and fat. It is involved in many other important biochemical processes such as the synthesis of cholesterol, the acetylation of drugs like the sulphonamides and the formation of acetylcholine, one of the chemical transmitters of nerve activity.

All these, and many other functions of the coenzyme, are described and fully documented. The early chapters deal with the events leading to its discovery, and with its preparation, properties and estimation. The information is well set out, much of it in tabular form, and the literature is covered up to and including 1958. It may be worth mentioning that the high cost of materials for present-day biochemical research is not only due to the need for expensive isotopes, for the cost of a gram of commercial coenzyme *A* runs into hundreds of pounds. Beside this, the cost of the book may not seem so high. It is very useful to have all this information collected together and the book should be in every biochemical library. D. C. HARRISON

Tables of Physical and Chemical Constants and some Mathematical Functions

By Dr. G. W. C. Kaye and Dr. T. H. Laby. Prepared under the direction of an Editorial Committee. Twelfth edition. Pp. viii+231. (London: Longmans, Green and Co., Ltd., 1959.) 25*s*. net.

THE latest edition of this admirable book is, like its predecessors, an outstanding work of reference of which its editorial board and contributors can be justly proud. So many complimentary things have been said in the past about previous editions that it is difficult to add anything more. Suffice it to say that the present edition more than maintains its great tradition for accuracy and clearness in the presentation of the abundant data, and that it remains an indispensable book for all students of physics and chemistry and their teachers.

The tables have been thoroughly revised and brought up to date, and certain sections, like radioactive and stable isotopes, have been extended to bring them into line with modern times, while the general atomic constants have been entirely recalculated.

Extensive changes have also been made in the chemistry section, in particular with chemical thermodynamics and electro-chemistry, while in the physics section the main revisions have been under the headings time, elasticity, full radiation and atomic physics. But in spite of the inevitable changes and modifications, this edition has the same essential features as before. It is still "Kaye and Laby", the friend and guide of countless numbers of students of successive generations, for it continues to be a completely reliable source of an amazing amount of essential material expressed so clearly, concisely and accurately. T. M. YARWOOD

Atomic Terminology

A Dictionary of Nuclear Science, Engineering and Technology in Four Languages (English–German–French–Italian). Compiled by Lore Lettenmeyer. (Die Fremdsprachen in der Praxis, Reihe B, Band 1.) Pp. 298. (München: Isar Verlag; London: Temple Press, Ltd., 1958.) 42*s*. net.

WITHIN the limits of its scope, "Atomic Terminology" is a model of what a multilingual dictionary should be. In the main part of the work, where the order is English alphabetical, each of the 1814 entries is given a number; this number is repeated before the German, French and Italian equivalents, and is also used in the indexes in each of these three languages. English synonyms are listed together, but each appears also in its alphabetical place with a cross-reference. The fact that the number of synonyms is, on occasion, as many as thirteen indicates the thoroughness with which the compilation has been carried out.

The keeping of the dictionary to pocket size has naturally imposed limitations: there are no definitions, and no information about sources, so that the user cannot tell *a priori* which forms are in common use and which, if any, have been coined by the compiler. Nevertheless, the general impression is one of careful and reliable lexicography, and this is confirmed by the extreme paucity of obvious errors: half a dozen misspellings such as 'Cockroft', and as many terminological inexactitudes such as 'restricted theory of relativity', in almost 300 pages. Dr. Lettenmeyer's valuable work is to be warmly recommended to all who have occasion to seek quick reference to correct equivalents of terms in the field of nuclear energy. J. B. SYKES

Electromagnetic Phenomena in Cosmical Physics

Edited by B. Lehnert. (International Astronomical Union Symposium No. 6, held in Stockholm, August 1956.) Pp. xiii+545. (Cambridge: At the University Press, 1958.) 50*s*. net.

THIS volume testifies to the increasing interest in electromagnetic phenomena which has characterized research in cosmical physics during the past decade. It is a subject in which simultaneous development and combination of theoretical, experimental and observational work are necessary, and this is reflected in the topics discussed at the symposium. Part 1 is devoted to magneto-hydrodynamics, and both theory and laboratory work are discussed. The paper by W. H. Bostick on the experimental study of plasmoids is of especial interest.

Part 2 is devoted to solar electrodynamics, Part 3 to stellar magnetism and Part 4 to solar and interplanetary magnetic fields. The papers in these three parts give a good indication of the importance of electrodynamic phenomena in astrophysics. It is not surprising that in this very live field few of the papers reach final conclusions, and they serve to emphasize how little we really know about the phenomena.

Part 5 is mainly concerned with cosmic rays, Part 6 with high current discharges and Part 7 contains a number of additional contributions on various subjects. From the vigorous discussions after the papers it is clear that the symposium was a success and of much benefit to the experts. The casual reader will not find this collection of papers suitable for general reading, and must await the production of a more systematic treatment of the subject.

R. H. GARSTANG

Nuclear Reactor Physics

By Prof. Raymond L. Murray. Pp. xi+317. (London: Macmillan and Co., Ltd., 1959.) 30*s*. net.

THIS is a reprint of the 1957 American edition and therefore contains no references to developments since 1956. It presents a clear and concise introduction to the basic equations and physical concepts, and its reappearance at a price which is now within reach of the student is to be welcomed. The author covers the basic areas of reactor physics, starting with those problems for which simple mathematical models provide an adequate approximation, and develops the power of the mathematical techniques as the book proceeds and as they are needed to cover the later, more complex, problems.

A feature of the text is the illustration of each development of the theory by applying it to a specific physical problem; a list of problems is also provided at the end of each chapter. These provide a very effective technique for showing the student what can be done with the theory.

The reader should, however, note that although this book is an excellent elementary text, the use of modern high-speed computing machines has meant that the calculation procedures currently in use for the solution of reactor problems differ appreciably from those described in Prof. Murray's book.

J. Fell

Physics and Mathematics

Vol. 3. Edited by Donald J. Hughes, J. E. Sanders and J. Horowitz. (Progress in Nuclear Energy, Series 1.) Pp. viii+403+xii. (London and New York: Pergamon Press, 1959.) 105*s*. net.

THE second (1958) Geneva Conference on the Peaceful Uses of Atomic Energy differed from the first in that the declassification of much of the early work was complete, and so attention was concentrated more on critical appraisal and interpretation, rather than on the mere presentation of data.

This third volume in the series "Physics and Mathematics" contains a selection of some twenty-one papers considered by the editors to be the most significant contributions to the dozen or so sessions on the physics of atomic energy. There can be no doubt that several of the papers, which cover the fields of neutron cross-section measurement, the physics of fission, neutron thermalization theory, and other aspects of reactor physics, are of great significance. For example, Leachman's paper on "The Fission Process" fills a very definite need for a readable review of recent data and theories on this controversial subject.

It can inevitably be argued that certain papers have been included the fields of which are too narrow, and that other, possibly better, papers have been excluded. It is the opinion of this reviewer, however, that the volume contains a selection of papers which will form a most useful reference work for any physicist interested in the more fundamental aspects of reactor physics.

E. R. Rae

A Student's Introduction to Physics

By Franklin Miller, Jr. Pp. xv+608. (London: Routledge and Kegan Paul, Ltd., 1959.) 50*s*. net.

THE author of this copiously illustrated text-book believes that all students can, and should, be familiar with the basic principles of physics, and accordingly he covers the whole field from its nature to the structure of the atom and nuclear energy.

The student requires no mathematics beyond simple algebra, and principles are emphasized rather than technological applications, though several of these are dealt with.

For a text in elementary physics there are several departures from the orthodox presentation. For example, the structure of the atom is introduced very early and students become acquainted with protons, electrons, neutrons and isotopes almost at the start. For a book of this scope I agree this is the correct approach, since there is no doubt much interest is taken nowadays by the ordinary student in anything pertaining to what is termed 'modern physics', and the early introduction must act as a stimulus to learn more about the principles of classical physics.

Another sensible innovation is the elimination of all reference to conventional positive current; the text deals only with direction as indicated by the electron flow.

Metric and f.p.s. units are used in mechanics, but only M.K.S. units are used in the section on electricity and atomic physics, thus keeping in line with modern practice.

Many worked examples, questions and problems are included in the book; the text, supported with many diagrams and illustrations, is well written and thoroughly done and it should certainly fulfil the aim of its author.

T. M. Yarwood

Analyse de Variance et Plans d'Expérience

Par Prof. Daniel Dugué et Prof. Maurice Girault. (Probabilités Statistique—Recherche Opérationnelle. Section B: Statistique Mathématique.) Pp. xiii+68. (Paris: Dunod, 1959.) 800 francs.

THIS short book gives a compact account of the elements of analysis of variance and experimental design. By English standards, its compounding of very elementary ideas on standard distributions and models with methods for design construction based upon Galois fields and vector spaces reads strangely; however, this book appears to be a successful execution of this intention. Necessarily the limitation of length prevents adequate critical discussion of the ways in which the designs should be used. Ascription of the distribution of the ratio of two independent χ^2 variates to 'Behrens–Fisher' is surprs ing.

D. J. Finney

Between Earth and Space

By Dr. Clyde Orr, Jr. Pp. ix+253+8 plates. (New York: The Macmillan Company, 1959.) 34*s*. 6*d*.

THE future of mankind has always been a concern of thinkers, the deleterious effects of Man's own activities having prompted many pamphlets. The substance of such a tractate might well be drawn from the last two chapters of this book. One of these deals with atmospheric pollution, and here, as might be expected from a chemist, Dr. Orr is at his best, the subject-matter being of higher quality than is suggested by such a poetic title as "A Ravaged Realm".

The twelve earlier chapters give a non-technical account of man's environment and its evolution. The presentation is more that of a popular lecture than that of a text-book and flows easily. As seems inherent in this type of treatment, there are statements as of fact which the specialist would accept

only as possible hypotheses. The initiate is, however, not seriously misled, being shown a balanced picture with a spice of the more spectacular phenomena.

A selected reading list is given of some two hundred references from a wide variety of sources largely of a popular or semi-popular nature. This list is not classified, there is no reference to it in the text, nor is there any indication of which part of each reference is thought to be apposite. To pursue every reference would take even the most assiduous reader quite some time, an unduly heavy task to develop from an easily read book which itself supplies good light relaxation.

B. R. LEATON

Man's Conquest of the Stars

By Pierre Rousseau. Pp. 356. (London: Jarrolds, Publishers (London), Ltd., 1959.) 25*s*. net.

IN this book the author has attempted to show how the development of astronomical science has influenced, and been influenced by, human methods of thought. When primitive man first turned to agriculture he needed the stars to forecast the changes of the seasons. The sophisticated thinkers of the Greeks attempted to encase astronomy in their different philosophies—whether the perfect circles of Plato or the divine harmony of Pythagoras. When Europe was submerged by the Dark Ages, the Arabs maintained the study of astronomy, chiefly to ensure that the Moslem hours of prayer were accurately fixed. When the Renaissance dawned, the new discoveries of astronomy helped to break the chains that fettered human thought. In succeeding centuries the great explorations stimulated the study of navigation, and the industrial revolution made possible the construction of instruments of greater power and accuracy.

This history is fully developed in M. Rousseau's book; but the most powerful part is his discussion of the contribution of the seventeenth-century scientist-philosophers Descartes, Newton, and their contemporaries. They invented methods which led directly to the 'scientific method' as we understand it to-day. The author assesses the stature of each new school of astronomy by the closeness with which it adheres to this method.

It should not be thought from the above remarks that this is a closely reasoned philosophical treatment —the style is racy and frequently enlivened by anecdotes. However, this style is virtually irreconcilable with spherical astronomy, which is made unnecessarily obscure in comparison with the rest of the book.

D. H. P. JONES

Astronomy

A Textbook for University and College Students. By Dr. Robert H. Baker. Seventh edition. Pp. viii+547. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: D. Van Nostrand Company, Ltd., 1959.) 52*s*. 6*d*.

THIS work is an excellent descriptive handbook of modern astronomy and astrophysics. It is the seventh edition of a book originally published in 1930, but has been completely rewritten and embraces all new developments up to 1958. However, it is not encyclopædic in approach; the author has been at pains to describe the context as well as the content of each section so that the subject appears as an organic whole. Thus radio-astronomy appears not as a self-contained unit but as the means for demonstrating the spiral nature of our galaxy, the size of which is known from optical means. The photo-electric measurement of the apparent brightnesses of stars is shown to lend a greater precision to the cosmic distance scale. Earth satellites had not made much direct contribution to astronomy at the time of publication, and they receive a correspondingly small mention.

All this information is conveyed in a lively and lucid style and there are plenty of really good photographs. Line diagrams are often used to illustrate more obscure points. In the preface the author states that no special knowledge of mathematics or physics is required; this rather vitiates its value as a university text-book. However, it would make a good reference to the descriptive part of a general course in astronomy as well as being an intelligible introduction for the layman.

D. H. P. JONES

The Sun and Its Influence

An Introduction to the Study of Solar-Terrestrial Relations. By Prof. M. A. Ellison. Second edition (revised). Pp. xiv+237+9 plates. (London: Routledge and Kegan Paul, Ltd., 1959.) 25*s*. net.

THE second edition of Prof. Ellison's book is the same as the first except for a few corrections and an added description of the solar cosmic ray event of February 23, 1956. The book is an authoritative factual description of solar activity and its terrestrial effects. It is written for the general reader, but provides a stimulating narrative for students or workers interested in any of the phenomena operating between the Sun and the Earth. The solar problems studied are the solar atmosphere, solar radiation, radio emission and various aspects of the solar cycle. Special attention is given to solar flares. The main terrestrial effects are to be found in the ionosphere, the Earth's magnetism, and auroræ.

C. W. ALLEN

A Concrete Approach to Abstract Algebra

By Prof. W. W. Sawyer. Pp. v+235. (San Francisco: W. H. Freeman and Co.; London: Bailey Bros. and Swinfen, Ltd., 1959.) 1.25 dollars; 10*s*. 6*d*. (paperbound).

IN abstract algebra, the novice is sometimes perplexed by the contrast between the almost ludicrous simplicity of the techniques and the profundity of the concepts, and may accept the logic of a modern text without acquiring any real grasp of the subject. To help him, Prof. Sawyer begins with a simple concrete model: a child with no arithmetic and no English, placed in an English schoolroom, might soon learn to associate the responses "four" and "six" with the teacher's demands, "Two and two make . . .", "Two times three is . . . ", and thus arrive at formal addition and multiplication tables without having any knowledge of the specific character of the elements to which these tables apply. By insistence on such concrete models, the author is able to emphasize the structure of an algebra, to deal with such topics as finite arithmetics, extensions of fields, and vector spaces, without inducing a feeling of unreality. A final good chapter shows how these notions can be applied to the familiar old problem of the trisection of an angle. Prof. Sawyer writes clearly and entertainingly: there are many non-mathematicians who want to know what modern mathematics is doing, and they will find this book helpful, though some references for further reading might well have been supplied.

Differential Geometry

By Prof. Erwin Kreyszig. (Mathematical Expositions, No. 11.) Pp. xiv+352. (Toronto: University of Toronto Press; London: Oxford University Press, 1959.) 48*s*. net.

THE calm backwater of classical differential geometry was stirred up by the general theory of relativity and is now once more in the main stream: Prof. Kreyszig keeps within familiar euclidean space, but has in mind extensions to Riemannian geometry. He first deals with the curvature and torsion of a curve, defined rather artificially as normalizing factors for certain vectors associated with the curve, but quickly related to the more concrete notion of the components of the angular velocity of the fundamental orthogonal triad. Then he discusses the first and second ground forms for a surface and geodesic curvature, using tensor methods which are introduced and elaborated as they are needed. This part of the book gives the minimum which every mathematician must know, and Prof. Kreyszig has taken pains to make the argument both detailed and rigorous. For the rest of the book he selects certain more advanced topics of importance. There is a very good chapter on mapping, in which the unifying power of this concept is illustrated. Another chapter deals with Levi-Cività's parallel displacement as an introduction to the general theory. The final chapter covers a variety of special topics, such as minimal surfaces and surfaces of constant Gaussian curvature. Exercises for the student are interesting and not oppressively numerous. The teacher should find this book helpful because of the care with which topics have been chosen from a very wide field, and because of the skill with which analytical rigour and geometrical intuition have been mated.

Britain's National Parks

Edited by Harold M. Abrahams. Pp. 151+40 photographs. (London: Country Life, Ltd., 1959.) 25*s*. net.

WHEN the first British national park was designated ten years ago it was hoped, in Lord Birkett's words, that "the fairest places in these islands will be secure from all assault arising from accident or design". With ten parks created this has proved to be far from the truth, and those who administer the parks need all the support they can get to resist the encroacher, both private and public.

This beautiful book, made up of a series of articles by men and women who know their parks lovingly and intimately, supported by photographs of the quality one expects from the publisher, should encourage all readers to join the ranks of those who see to it that encroachments are not made without due cause.

British Industries and Their Organization

By Prof. G. C. Allen. Fourth edition. Pp. xi+332. (London: Longmans, Green and Co., Ltd., 1959.) 25*s*. net.

IN this edition Prof. Allen has largely re-written his book, which was first published in 1933 and substantially revised in 1951. The first chapter, which is substantially unaltered, traces the chief features of British industrial growth up to 1914, and the second chapter, much enlarged, outlines the economic history of the period from 1914 to 1959, so far as is relevant to the main theme of the book. The remaining ten chapters are concerned with particular industries; but, as in previous editions, the chemical and electrical industries are not included, and the book suffers a little in consequence. The select bibliography has also been completely revised.

R. BRIGHTMAN

Biographical Memoirs of the National Academy of Sciences of the United States of America

Vol. 33. Pp. vi+484+16 plates. (New York: Columbia University Press; London: Oxford University Press, 1959.) 40*s*. net.

THE "Biographical Memoirs" of the U.S. National Academy of Sciences are the counterpart of the Obituary Notices of the Royal Society, and Vol. 33 worthily maintains the high standard. The memoirs it contains are noteworthy for the completeness of the bibliographies appended to each memoir, but the time-span is exceptional, ranging from Josiah Boyce (September 14, 1916) and M. C. Wood, jun. (January 3, 1920) to P. D. Merica (October 20, 1957), though apart from Dunham Jackson (1946) and T. H. Morgan (1945) the subjects of the remaining memoirs died between 1950 and 1957. Among the memoirs likely to be of the widest interest to British readers are those of Isaiah Bruman, R. A. Millikan and L. F. Small.

The Wealth of India

A Dictionary of Indian Raw Materials and Industrial Products. Raw Materials, Vol. 5: H–K. Pp. xxv+332+xii+16 plates. (New Delhi: Council of Scientific and Industrial Research, 1959.) Rs. 30.

THE appearance of the fifth volume of this work will be welcomed, the first volume having appeared twelve years ago. According to the chief editor's introduction it is considered that half the total work has now been printed. With the machinery for the preparation of this gigantic task now apparently well organized and tried, it may be that the remaining five volumes will be completed in a shorter time. It would seem that the task may well take twenty years to complete. This is not unduly long, however, when one considers how long other similar large tasks, involving several authors, take to complete. For example, some of the large tropical floras now in preparation are unlikely to be completed in less than twenty or even thirty years.

This volume follows a similar pattern to the previous four volumes and contains a great deal of useful information presented in a form readily intelligible to the ordinary reader. It is well illustrated with line drawings, photographs and a few coloured plates. The coloured frontispiece is the sunflower (*Helianthus annuus*), which is, of course, of American origin. A typically Indian economic plant would perhaps have been more appropriate.

The volume deals with the raw materials falling under the letters H–K. It contains 380 entries—370 on plants, 7 on animals and 3 on minerals. The preponderance of plant raw materials, compared with animal and mineral, is no cause for surprise to those familiar with the amazing richness in economic plants which Nature has so generously bestowed upon the Indian sub-continent. Important products in this volume include—*Hevea* (rubber), *Hibiscus* (with several different economic plants), *Hordeum* (barley), *Hydnocarpus* (chaulmoogra oil), *Indigofera* (dyes), *Ipomoea* (sweet potato), jade, *Jasminum* (perfumes) and *Juglans* (walnut).

F. N. HOWES

(*Continued from p.* 34)

applied intermittently to the fine grains subjected to the 'grinding' actions in each of these types of apparatus.

That a real pressure component is operative in the action of the mortar assembly was shown by increasing or reducing the weight of the pestle-head assembly by means of a suitable weight or counterpoise to twice or one-sixth the normal weight. Thus, although about 20 per cent conversion of calcite to aragonite was achieved by only 13 hr. of grinding under normal weight, and about 5 per cent in the same time under half the normal weight, more than 100 hr. under the one-sixth weight failed to produce detectable amounts of aragonite. Presumably the greatly reduced weight of pestle is not sufficient to generate pressures greater than 3,000 bars on the calcite, leaving it still in its equilibrium field. Another example is the litharge–massicot transition of lead oxide in which litharge is the low-pressure (and also low-temperature) form. The action of the light-weight pestle (under nitrogen) will drive massicot readily to the stable litharge (this being merely the effect on kinetics due to bond breakage), but if litharge is the starting material no change to massicot is observed. To accomplish the latter the heavier pestle is necessary, presumably since only then is enough pressure available to reach the massicot field. On the other hand, the heavy pestle will produce some litharge when acting on massicot, because all values of pressure up to the maximum must be encountered, since the apparatus of necessity produces a whole 'spectrum' of pressures. A similar example was found on grinding a mixture of the senarmontite and valentinite forms of Sb_2O_3.

Thus it is clear that the stresses causing fracture generally operate to accelerate reactions, although the effect is larger in some pairs of structures than in others. Superimposed on this kinetic effect is a hydrostatic pressure effect. Detailed verification of the separability of the 'stress' and pressure effects has been effected[5] in an uniaxial high-pressure device[6] so modified that a slow continuous oscillating displacing shear action by the movement of one piston through 2° of arc is applied to samples (of the above compounds) simultaneously subjected to high pressures and temperatures. It is sufficient to mention here that it has been established that stresses in the form of displacing shear do not alter equilibrium pressures of transitions (within the experimental limits), although they do contribute enormously to the rates of such reactions.

Burns and Bredig[2] have already pointed out that the possibility of phase transformations taking place on grinding must be taken into account in explaining discrepancies in the behaviour of calcium carbonate. Our results show that: (1) 'grinding' or mixing, in both 'automatic mortars' and 'Wig-L-Bug'-type shakers not only can introduce appreciable amounts of surface and strain energy but also can quite generally cause the formation of high-pressure phases; (2) the effective maximum in the 'spectrum' of hydrostatic pressures obtained in such instruments is not less than about 15,000 bars; (3) in addition to the quasi-hydrostatic pressures exerted, the shearing stresses causing the breakage of bonds and/or the storage of strain energy result in a very marked acceleration on the kinetics of such transformations.

This work was done as part of the high-pressure studies under contract with the Office of Naval Research, Metallurgy Branch, *NONR*-656(20). We are also indebted to S. Merrin and D. Corrigan, who carried out some of the experiments reported.

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Strontium-90 in the 'Mixed Layer' of the Atlantic Ocean

OCEANOGRAPHY and marine geochemistry have only relatively recently been able to take advantage of isotopic tracer techniques; unfortunately, the conceptual framework devised for isotope studies in biochemistry and physiology is not readily applicable to systems of very large spatial extension.

In considering the significance of the ocean reservoirs in the geochemistry of carbon dioxide, and in using the distribution of carbon-14 to derive rates of ocean mixing in both vertical and horizontal planes, it has been conventional[1] to divide the oceans into shallow surface reservoirs assumed to be well mixed, and deep reservoirs assumed to be only slowly renewed from the surface. Since, in some applications, the quantitative expression of this picture is extremely sensitive to the assumed depth of the surface reservoir, and to its rate of renewal from below, it seems important to point out that these parameters are measurable by using relatively short-lived radioisotopes, which are added to the system at the surface. In the case of the Atlantic Ocean, North and South, this condition is well met by radioactive strontium-90 from bomb test fall-out. To the Atlantic, strontium-90 has been added, measurably, only as fall-out to the ocean surface. In this form the isotope is wholly soluble in water[2]; and in sea water, the dilution of the radioisotope by both stable strontium and stable calcium in solution is so great that neither biological nor chemical processes produce significant changes in strontium-90 concentration. Thus, its vertical transport depends wholly on vertical movement of the water in which it is dissolved.

As a part of an extended study of the marine geochemistry of long-lived radioisotopes from fall-out, we are obtaining a number of series of measurements of the change in strontium-90 concentration with depth in the ocean. Some of these measurements, together with descriptions of the methods employed, have been published[3]. We now present (Table 1) seven series of strontium-90 analyses, all but one previously unreported. These series agree in showing very significant concentrations of radiostrontium at depth in the open ocean, both north and south of the equator. The number of analyses is still too few to justify very precise integration of the curves of strontium-90 versus depth, but an average concen-

Table 1. Strontium-90 in Atlantic Water Columns

Station position	15° 49′ S. 35° 50′ W.	8° 26′ S. 7° 45′ E.	16° 15′ N. 43° 37·5′ W.	36° 23′ N. 70° 33′ W.	31° 15′ N. 68° 10′ W.	34° 30′ N. 65° 42′ W.	34° 39′ N. 67° 24′ W.
Date collected	1/2.4.57	1.3.57	22.11.57	13.7.57	8.12.57	11/12.7.58	15/16.7.58
^{90}Sr disinteg./min. per 100 litres at depth :							
0 m.	4·1 ± 0·5	5·0 ± 1·0	6·3 ± 0·6	10·5 ± 0·6	10·9 ± 0·6	7·6 ± 0·6	9·1 ± 0·6
100			5·4 ± 0·5		7·7 ± 0·6	13·0 ± 0·7	8·2 ± 0·6
300		2·4 ± 1·0				11·8 ± 0·9	5·5 ± 0·5
400			2·2 ± 0·3		3·9 ± 0·6		
500				4·1 ± 0·6		7·3 ± 0·4	6·4 ± 0·5
700		< 0·3			2·3 ± 0·4	3·7 ± 0·5	3·4 ± 0·5
1,000	1·5 ± 0·6			< 1·0		< 0·9	1·7 ± 0·3
1,200			1·6 ± 0·8				

Note.—Deviations reported are those expected from counting statistics only.

tration, from 300 to 700 m., of about half the surface value, is indicated. The upper 100 m. appears likely to be well mixed, as generally assumed, with a sharp gradient from 100 to 300–400 m. Appreciable concentrations at 1,000–1,200 m. are frequent, although we have never found measurable radiostrontium in samples from 3,000–5,000 m.

We wish to emphasize here only two features of these distributions: the indicated mass transport, and the time-scale. The water columns so far sampled appear to have from three to four times as much total strontium-90 below 100 m. as remains above that depth; and it is reasonable to assume that this radioisotope has all been added since mid-1954 [4]. The possibility of vertical transport by sinking along sigma-T surfaces appears to be strictly ruled out by the short times available, and the enormous horizontal distances which would have to be traversed. A more or less direct vertical movement by wind-driven mixing is indicated. The facts of the close agreement of samples from 400–500 m. from the two 1957 Sargasso Sea stations, and the significantly higher figures for the July 1958 stations, support the postulate of vertical transport during the winter period of surface-water cooling and high wind velocities.

It is unfortunate that present uncertainty about the mechanism and rate of stratospheric fall-out should preclude conversion of our figures for total vertical transport of strontium-90 into annual rates of down-mixing (and hence of up-mixing) of ocean surface-water in mid-latitudes. For this, more observations over a longer time span will be needed, and this will be profitably supplemented by the collections of precipitation which have begun on weather ships. It does now seem reasonable to point out that the same mechanism which has produced in three years at depths of 300–700 m. an approximately 1 : 1 mixture of surface-layer strontium-90, and pre-1954 sub-surface strontium-90, would have produced the same sort of dilution of surface sea-water carbon-14. Broecker's weighted average[5] of carbon-14 in North Atlantic water at 200–400 m. very closely approximates this same 1 : 1 ratio. Clearly, to assign the reduction in carbon-14 activity to radioactive decay, and conclude a 'crude age' of 290 years, become untenable, in the light of our demonstration that surface-added radioactivity reaches this same concentration ratio in three years. An attempt must be made to interpret these reductions in specific activity, and that in the surface layer as well, as standing concentrations maintained by mixing processes. Unlike the situation in biochemistry, here the gradient area across the boundary between two reservoirs contains a major fraction of the tracer in the system. A very much larger flux of carbon-14 across the sea surface must then be postulated to maintain the very much greater reservoir indicated. Our strontium-90 measurements, as well as the first of the weather ship fall-out measurements[6], indicate that much more fall-out may have been delivered per unit area to the sea surface than has been reported for the land. It is of course possible simply that the sea surface is a more efficient collector of fall-out than any which have been devised for shore-based study, and that retention in the water column is more reliable than on soil. Without a theory of the processes responsible for this difference, if real, we cannot tell whether this may also help to clarify the problem of the transfer of carbon-14.

A more detailed report of this work is being prepared for early publication elsewhere. Various aspects of the programme have been supported by the United States Atomic Energy Commission (contracts *AT* (30–1)—1918, *AT* (30–1)—2174), the United States Office of Naval Research (contract *NONR*–2196) and the United States National Science Foundation. Most of the stations mentioned have been collected as part of the U.S. International Geophysical Year programme.

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CHEMISTRY

Gas Content of Graphites

Artificial graphite for use in graphite-moderated nuclear reactors, as anodes for mercury vapour rectifiers, and crucibles for vacuum fusion work should contain little gas. Otherwise, when the graphite is heated to operating temperatures, the gas is desorbed, resulting in adverse effects. For example,

in the graphite-moderated nuclear reactor, hydrogen and carbon monoxide released from the graphite can interact with the fuel-cladding material (usually zirconium or stainless steel), resulting in hardening and embrittlement of the metal. Released carbon monoxide can disproportionate on cooler metal heat-exchanger surfaces depositing carbon, resulting in an adverse effect on the heat-transfer and flow properties of the system.

The present communication summarizes briefly results on the gas released from typical nuclear graphites (and an electrode graphite, for comparison) when degassed at an upper temperature between 1,500 and 2,000° C. *in vacuo*. For the degassing studies, a pumping system consisting of a liquid-nitrogen cold trap and a two-stage Van-Hespen mercury diffusion pump was used. Power to heat the graphite samples (1 in. long by ½ in. diam.) was supplied by a 5-kW. high-frequency induction generator.

Table 1 presents results for the gas released from a sample of nuclear (*A*) and a sample of electrode graphite. Both graphites were graphitized in an Acheson-type furnace, as described by Abbott[1]. For the nuclear graphite, the graphitizing was done in a chlorine (gas purified) atmosphere[2]; and the cooling was done in helium. For the electrode graphite, the atmosphere during heating and cooling consisted primarily of carbon monoxide and nitrogen which diffused in through the coke packing material. There were also significant pressures of carbon dioxide and oxygen at lower graphitizer temperatures, where the packing material did not completely convert oxygen to carbon monoxide.

Table 1. GAS RELEASED FROM GRAPHITES WHEN HEATED TO ELEVATED TEMPERATURES*

Property	Nuclear (*A*)†	Electrode‡
Total gas evolved (c.c./gm. at S.T.P.)	0·12	0·74
Analysis of gas evolved (vol. per cent)		
Hydrogen	59·4	30·8
Carbon monoxide	23·8	53·2
Carbon dioxide	12·7	16·0
Water	2·7	*N.D.*§
Hydrocarbons	1·4	*N.D.*

* Nuclear graphite degassed to 1,900° C.; electrode graphite degassed to 1,500° C.
† Surface area, 0·3 m.²/gm.; porosity, 25·2 per cent; ash, <0·004 per cent.
‡ Surface area, 0·4 m.²/gm.; porosity, 31·3 per cent; ash, 0·11 per cent.
§ Not determined.

For the results given in Table 1, runs were made on three different pieces of each graphite, with the results between each piece agreeing within 10 per cent. As expected[3], a considerably smaller quantity of gas is released from the nuclear than from the electrode graphite. This cannot be accounted for by a difference in Brunauer–Emmett–Teller surface area of the two materials. It is also noted that the percentage of carbon oxides in the evolved gas from the electrode graphite is considerably higher than from the nuclear graphite. Undoubtedly, this is a result of chemisorption by the electrode graphite of carbon monoxide, carbon dioxide and oxygen in the graphitizer and enhanced chemisorption of oxygen (because of the higher impurity content of the electrode graphite) at ambient temperatures following unpacking of the graphitizer. From other studies[4], it is concluded that the hydrogen released from a nuclear graphite is chemisorbed primarily on carbon atoms at crystallite edges.

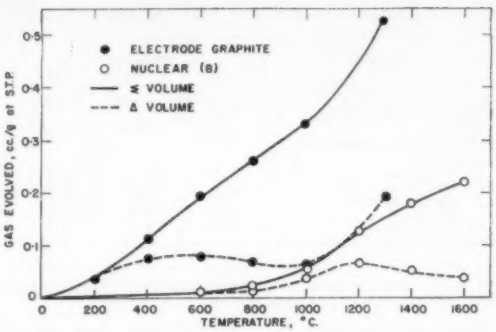

Fig. 1. Comparison of the integral and differential degassing curves for an electrode and a nuclear graphite

Gas-release from a thermally purified nuclear graphite (*B*), as a function of outgassing temperature, is compared with that from the electrode graphite (previously discussed) in Fig. 1 and Table 2. Because of the large amounts of carbon dioxide desorbed from the electrode graphite at low temperatures, a maximum in the differential degassing curve occurs at approximately 500° C. Another maximum (and higher) in the differential degassing curve of electrode graphite will occur above 1,300° C. On the other hand, for the thermally purified nuclear graphite (*B*), gas release below 800° C. is small; and only one maximum in the differential degassing curve is indicated at about 1,200° C. Interesting points to note from the results in Table 2 are:

(1) For the nuclear graphite (*B*), significant amounts of hydrocarbons are found in the gas up to 1,200° C. These gases consist mainly of C_2H_4, C_2H_2, C_2H_6, CH_4, and *iso*-C_4H_8, with C_2H_4 predominant at the lower temperatures and C_2H_2 predominant at the higher temperatures. It is uncertain what fraction of the hydrocarbons recovered is a result of reaction of carbon with desorbed hydrogen (ionized in the high-frequency induction coil)[4]. Carter and Greening[3] also reported hydrocarbons during the degassing of nuclear graphite.

(2) Considerably more water is recovered upon the low-temperature outgassing of electrode graphite than nuclear graphite (*B*). Since water adsorption on carbon occurs primarily at sites containing oxygen[5], this result is consistent with the fact that the electrode graphite originally contains more oxygen

Table 2. ANALYSES OF GAS EVOLVED FROM GRAPHITES OVER DIFFERENT TEMPERATURE INCREMENTS

Temperature increments (° C.)	Volume percentage of: H_2	CO	CO_2	H_2O	Hydrocarbons
	Nuclear (*B*)*				
20–600	34·4	20·8	16·9	7·7	20·2
600–800	43·9	10·8	10·0	4·6	30·7
800–1,000	54·6	7·2	3·1	2·9	32·2
1,000–1,200	63·9	7·3	1·4	nil	27·4
1,200–1,400	85·3	11·1	1·8	nil	1·8
1,400–1,600	70·8	24·4	2·5	nil	2·4
	Electrode				
20–200	8·7	14·1	22·8	43·5	10·9
200–400	4·8	21·4	59·5	11·9	2·4
400–600	45·0	36·2	3·8	2·5	12·5
600–800	51·9	38·3	nil	nil	9·8
800–1,000	36·4	63·6	nil	nil	nil
1,000–1,300	24·5	75·0	nil	nil	nil

* Surface area, 0·4 m.²/gm.; porosity, 25·2 per cent; ash content, <0·07 per cent.

Table 3. Effect of Graphitization Temperature and Atmosphere on Subsequent Gas Release upon Degassing at 2,000° C.

Property	Graphite* I	II	III
Ash content (per cent)	0·87	0·044	0·0006
Total gas evolved (c.c./gm. at S.T.P.)	0·93	0·36	0·20
Analysis of gas evolved (vol. per cent):			
Hydrogen	12·5	27·5	32·0
Carbon monoxide	52·0	53·5	48·5
Carbon dioxide	19·5	15·0	11·5
Water	13·5	3·0	7·0
Hydrocarbons	2·5	1·0	1·0
Sample weight loss (per cent)	0·19	0·13	0·05

* The maximum graphitization temperatures for I, II and III are 2,600, 3,000 and 2,700° C., respectively.

(ultimately desorbed as carbon dioxide and carbon monoxide).

(3) An increase in the carbon monoxide : hydrogen ratio of the desorbed gas at outgassing temperatures above 1,000° C. for the nuclear graphite (*B*) and above 600° C. for the electrode graphite indicates that an important fraction of the carbon–oxygen complex leading to carbon monoxide has a higher thermal stability than has the chemisorbed hydrogen.

Table 3 presents results for the gas released from three samples of graphite following heat treatment under different conditions. All samples were outgassed at a maximum temperature of 2,000° C. Graphites I and II were heated and cooled under an atmosphere similar to that used for the electrode graphite. Graphite III was treated in a halogen atmosphere and cooled (flushed) in an inert gas atmosphere to about 1,500° C. It is seen again that the use of a halogen atmosphere during graphitization (and perhaps cooling, in part, in an inert atmosphere) is particularly effective in reducing the subsequent amount of gas released from the graphite. As previously discussed[3], this is related probably to enhanced removal of metallic impurities. These impurities can be oxidized and/or catalyse the chemisorption of gases on carbon. In the former case, the reduction of these metal oxides by carbon at high degassing temperatures leads to gaseous carbon oxides.

The sample weight losses, given in Table 3, are a result of both gas desorption and metal volatilization. For example, for graphite I, each process accounts for about 50 per cent of the loss of weight. Considerable material was collected on the cool walls of the desorption chamber during the degassing of sample I. An emission spectroscopic analysis indicated that the main constituents of the deposit were silicon, iron and magnesium.

The kinetics of the adsorption and desorption of hydrogen on nuclear graphite will be reported on in more detail elsewhere.

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Optical Properties of the αω-Dimethanesulphonoxyalkanes

The well-known alternation of the melting points with chain-length of a homologous series of compounds (for example, the normal paraffins, mono- and di-basic fatty acids, *n*-acetyl L-amino-acids) has been observed in the series of αω-dimethanesulphonoxyalkanes $CH_3SO_2O(CH_2)_nOSO_2CH_3$ [1]. The melting points of this series are shown plotted in Fig. 1, from which it is observed that the butane derivative ($n = 4$) exhibits a melting point which is very much larger than the rest of the series. A discontinuity of this kind is unusual, and it is of interest to examine it further.

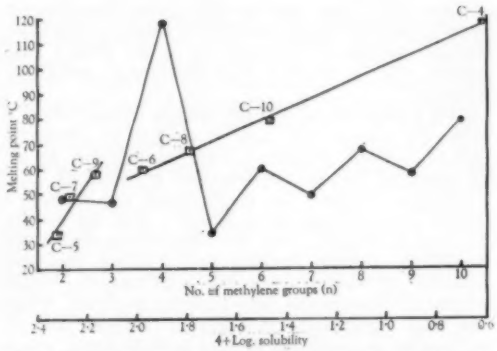

Fig. 1. Physical properties of the αω-dimethanesulphonoxyalkanes. ⊙, Variation in melting point with number of methylene groups; ⊡, relationship between melting point and logarithm of solubility in ether (C–4, butane derivative, etc.)

The alternation in properties of the odd and even members of the αω-dimethanesulphonoxyalkanes is reflected in their solubilities in an organic solvent, ether. Thus, as shown in Fig. 1, the odd and even series respectively show a linear relationship between their melting points, T_m, and the logarithm of their solubilities, S, that is, $\log S_\infty - T_m$. In terms of the Clausius equation, for ideal solution:

$$\ln S = -\frac{L_f}{R}\left\{\frac{1}{T} - \frac{1}{T_m}\right\} = -\frac{L_f}{T_m}\left\{\frac{T_m - T}{RT}\right\}$$

for constant-pressure conditions, where L_f is the latent heat of fusion of the solute and T is the temperature at which the solubility (as the mole fraction) is measured. The rectilinearity between $\log S$ and T_m suggests that, over the limited range considered, L_f increases approximately proportionately to T_m. Then $\log S = -\frac{\alpha(T_m - T)}{RT}$. The slopes of the lines for the two series differ by a factor of about 4, suggesting that the change in L_f with chain-length in the even series is greater than that for the odd series. Similar effects have been observed with other series, for example, the fatty acids[2]. It will be noted that the butane derivative ($n = 4$) exhibits the solubility properties characteristic of the even series in this respect.

The crystal form and optical constants of the compounds have been determined to examine whether the difference in the butane compound is easily interpreted in terms of the crystal structure. The values obtained are given in Table 1.

Table 1. THE OPTICAL PROPERTIES OF THE αω-DIMETHANESULPHONOXYALKANES

No. of methylene groups (n)	Crystal system	Habit	Refractive indices			Birefringence $n_\gamma - n_\alpha$	Optical data		
			n_α	n_β	n_γ		Sign	Optic axial angle	
								Range of values	Most common value
3	Orthorhombic	needles	1·489	1·504	1·513	0·024	−	66–71°	69°
4	Monoclinic	plates	1·510	1·520	1·566	0·056	+	48–55°	54°
6	Monoclinic	needles	1·477	1·504	1·523	0·046	−	68–86°	74°
7	Monoclinic	plates	1·490	1·499	1·554	0·064	+	38–45°	42°
8	Triclinic	plates	1·497	1·512	1·575	0·078	+	49–60°	55°
9	Monoclinic	plates	1·495	1·502	1·564	0·069	+	38–41°	40°
10	Triclinic	plates	1·500	1·517	1·580	0·080	+	43–56°	51°

The compounds are white crystalline solids, although some difficulty is sometimes met in crystallizing the n-pentane member of the series: this compound was not used in this study. The three principal refractive indices were determined with a three-axis universal stage by the immersion method using monochromatic sodium light and the values given have a reproducibility of + 0·002. The optic axial angle ($2V$) was determined orthoscopically.

The crystal habit of the compounds and the orientation of the elements of optical symmetry have been used to assign them to a crystal system. No goniometric measurements have been made, and more detailed work by X-rays is needed to determine the fundamental crystallographic constants.

Optically, the compounds fall into two main groups: (*a*) those with $n = 7$–10; (*b*) those with $n = 3$–6. The optical constants of the compounds containing 7–10 methylene units show good agreement with the results obtained from melting point and solubility determinations. Two sub-series can be recognized: those in which n is an odd number and those in which n is even. Crystallography, optic axial angles, refractive indices and birefringence all accord within each sub-series, but can be used to distinguish between them.

The compounds for which $n = 6$ or less show no such simple relationship. The butane derivative ($n = 4$), which is abnormal in the melting point sequence, shows good agreement optically with the series $n = 8$–10, indicating that its abnormality is not due to fundamentally different crystal structure. The compounds in which $n = 3$ and $n = 6$ show rather unexpected similarities. Both are acicular in habit, although the hexamethylene compound ($n = 6$) is monoclinic whereas the trimethylene compound ($n = 3$) is orthorhombic. They are the only members of the series investigated which are optically negative and which have large optic axial angles (about 70°); the other compounds have optic axial angles of about 40–50°.

The investigation indicates that there is a strict correlation between chemical and optical properties in the compounds containing seven or more methylene groups. The crystallography and optical properties appear to be controlled by the number of methylene groups in the structure; compounds in which n is even are triclinic, whereas when n is odd the crystals exhibit monoclinic symmetry. The crystallography of compounds in which $n = 6$ or less may, on the other hand, be controlled by the methanesulphonoxy end groups which are large in relation to the remainder of the structure. The abnormally high melting point of the butane derivative ($n = 4$) reflects a high lattice energy which, although it is not revealed crystallographically, may be due to the relative positions of the large end groups in the space lattice.

The optical properties of a great number of such compounds have been listed by Winchell[3].

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Requirements for Stereospecificity in Hydrolysis by Chymotrypsin: Diethyl β-Acetamidoglutarate

As part of our study of the relation of structure of substrate to stereospecificity in enzyme reactions[1], we wish to report asymmetric hydrolysis of diethyl β-acetamidoglutarate by α-chymotrypsin. This compound was prepared by acetylation of diethyl β-aminoglutarate[2], b.p. 142–144°/2 mm.; anal. calc. for $C_{11}H_{19}NO_5$: C, 53·88; H, 7·81; N, 5·71. Found: C, 54·33; H, 7·84; N, 5·50. (Chymotrypsin was from Worthington, salt free.) A solution of 0·544 gm. of the ester and 0·524 gm. of the enzyme in 52·4 ml. of 0·02 *M* phosphate buffer was allowed to react at 27° in a *p*H-stat at *p*H 7·8, one ester group being 80–85 per cent hydrolysed in 5 hr. The reaction showed reproducible first-order kinetics, $k_1 = 0·0057$ min.$^{-1}$, indicating extremely weak catalytic activity. However, the reaction was stereospecific. Neutralization of the alkali which had been added, evaporation to dryness and extraction with acetone led to optically active monoethyl-β-acetamidoglutarate, 0·318 gm., 78 per cent yield, m.p. 93–94 per cent. $[\alpha]_D^{25°}$ + 5·9° (5 per cent acetone)[3]. Anal. calc. for $C_9H_{15}NO_5$: C, 49·73; H, 6·96; N, 6·45. Found: C, 49·80; H, 6·92; N, 6·51. The half-ester was prepared in the racemic form by hydrolysis of the di-ester to the di-acid, β-acetamidoglutaric acid, m.p. 185–186° dec., anal. calc. for $C_7H_{11}NO_5$: N, 7·41; found: N, 7·38; conversion of the di-acid to β-acetamidoglutaric anhydride, m.p. 140–141°; anal. calc. for $C_7H_9NO_4$: C, 49·11; H, 5·30; N, 8·18; found: C, 49·05; H, 5·26; N, 8·16; and conversion of the anhydride to racemic monoethyl β-acetamidoglutarate, m.p. 77–78°. Anal. found: C, 49·71; H, 6·92; N, 6·42. The racemic and (+) monoesters had identical infra-red spectra in chloroform.

Asymmetry is shown despite the lack of the two structural features which are characteristic of specific

substrates for chymotrypsin[4], the beta-aryl and alpha-acylamido groups, which do lead to high reactivity if the stereochemistry is correct. These two groups, combined with that undergoing hydrolysis, have been thought to provide the three-point contact which has been considered necessary for asymmetry in this type of reaction[5], and for stereospecificity[6], and in particular for stereospecificity in hydrolysis by chymotrypsin[7]. However, the beta-aryl group is neither necessary nor sufficient[8] to lead to stereospecificity, while the acetamido group in either the alpha or the beta position does lead to stereospecificity in the hydrolysis of the malonate[1] and glutarate esters respectively, in which the presumed three-point contact cannot be occurring. Classical diastereomeric interactions may in principle account for asymmetric reactions of molecules of type *Cabdd* with enzymes and with other optically active reagents[9]. Scale models show that as the functional group of an asymmetric molecule attacks one group *d* of *Cabdd*, other groups of the reagent interact differently with the groups *a* and *b* at the developing centre of asymmetry *C*, depending upon which of the groups *d* is attacked. Such diastereomeric interactions of the acetamido group with rather rigidly organized asymmetric chymotrypsin may suffice to lead to reaction via preferred orientations and to stereospecificity.

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Structure of the Viscous Phase of Liquid Sulphur

Transitions in the liquid phase have been reported for few substances. However, sulphur has been extensively studied and the variation of most of its properties through the transition region determined[1].

At present the mobile phase S_λ, obtained on melting, is thought to consist principally of S_8 rings which open at the transition temperature of 159° and polymerize to chains of 10^4–10^6 atoms to form the S_μ phase. Evidence for the chain structure is based mainly on an interpretation of the viscosity results of Bacon and Fanelli[2], which attain a maximum of 930 poises at 166°. Powell and Eyring[3] suggested that, as the addition of as little as 0·02 per cent of iodine is capable of suppressing the viscosity maximum from 930 to 57 poises, iodine tends to add terminally to the free valencies formed when the S_8 rings open at the transition temperature, so preventing excessive chain growth.

It is possible, however, to check this hypothesis by allowing sulphur alone in the viscometer to attain its maximum viscosity at 166°, when the long chains, if present, should be fully formed, and then making the iodine addition. If the long-chain hypothesis is correct, the addition of iodine *in situ*, at this temperature, should only have a minor effect on the viscosity maximum as it will add terminally at the free valence ends of the chain. If this is done, however, it is found that the viscosity maximum is still suppressed.

This suggests that unless the iodine is able to split a sulphur chain as readily as add terminally, which is unlikely, long chains of the order estimated by Gee[4] of 10^6 and Powell and Eyring of 10^4 are not present in the viscous phase.

On the basis of the thermal conductivity, viscosity, self-diffusion and surface tension data a different model of the structure of S_μ sulphur has been proposed[5] which does not necessitate the postulated existence of long chains. In this model the sulphur units in the viscous phase have only an average molecular complexity of 20–30 atoms. However, when the S_8 rings of the S_λ phase open at the transition temperature and polymerize slightly, the new units formed at this temperature are well below their normal freezing point. In such a supercooled state the viscosity naturally attains very large values.

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BIOCHEMISTRY

Bradykinin Activity of some Synthetic Peptides with only Slight Structural Resemblance to Natural Bradykinin

Recent findings[1] have indicated an unexpected kind of structural specificity among biologically active peptides. Although minor changes in chemical structure may reduce or even abolish a particular biological activity, large and sweeping changes sometimes do not destroy potency. Thus, in such peptides as strepogenin, oxytocin, lycomarasmin and gramicidin *S*, neither the sequence of amino-acid residues in the peptide nor the actual amino-acid composition of the naturally occurring peptide is essential for biological activity. We have therefore sought to examine this situation further, and to determine whether it applies to other kinds of biologically active peptides. We have found that it does apply to bradykinin.

Pure bradykinin has only very recently been isolated[2] and shown to be an octapeptide composed of arginine, proline, phenylalanine, glycine and serine. At the time this result was announced, we had isolated from enzymic digests of insulin the disulphide of leucylvalylcysteinylglycylglutamylarginine (a peptide with strepogenin activity), and had synthesized it[3]. As by-products of the synthesis, several related peptides were also available. Because these compounds were of nearly the same size as bradykinin, and, like it, contained arginine, assays of their

Table 1. Amounts of Compounds necessary to cause Maximal Contraction

Compound	Ileum (mgm./ml.)	Uterus (mgm./ml.)
Bradykinin*	5×10^{-6}	5×10^{-7}
A	inactive at 10	—
GlA	inactive at 12	—
$(LVCGGlA)_2$	inactive at 2	inactive at 0·1
$(LVCGGlA\ diamide)_2$	1·4	0·14
$(LVCG\textit{iso}GlA)_2$	0·2	0·1
Histamine	5×10^{-6}	—
Serotonin	—	1×10^{-5}

A = arginine, Gl = glutamyl, G = glycyl, C = cysteinyl, L = leucyl, V = valyl and *iso*Gl = a glutamic acid residue joined by the γ-carboxyl group to the amino-group of the next amino-acid.
* Values given are for pure bradykinin and were taken from a personal communication from Dr. D. F. Elliott.

ability to function as bradykinin were carried out. It was felt that if the situation outlined at the start of this communication had general validity, some of the synthetic peptides should show bradykinin activity. Thus, the only amino-acids in common among the synthetic peptides and natural bradykinin would be arginine and glycine.

Assays were performed as described by Roche e Silva[4]. Both the isolated guinea pig ileum and the isolated rat uterus were used. The former was standardized with histamine, and the latter with serotonin. The peptides available were glutamylarginine and the disulphide dimers of leucylvalylcysteinylglycylglutamylarginine, its diamide, and leucylvalylcysteinylglycyl*iso*glutamylarginine. These were dissolved in the salt solution appropriate for each type of assay, and the *p*H of the solutions was adjusted to that of the test system. Each active peptide gave the typical slow contraction of the muscles shown by natural bradykinin, and the effects were not overcome by an antihistamine (benadryl).

The results are summarized in Table 1. There it can be seen that some only of the peptides exhibited activity. Consequently, a mere peptide of arginine, or of arginine and glycine, was not enough. Free arginine likewise was inactive. Note that although leucylvalylcysteinylglycylglutamylarginine was inactive up to 2 mgm., its diamide was potent. This might suggest that overall charge on the molecule was important for activity, especially since natural bradykinin contains no dibasic amino-acid residue. However, the corresponding *iso*glutamyl peptide, which has approximately the same charge as its isomeric inactive relative, was active. One might say that so long as the gamma carboxyl group of glutamic acid in the peptide was substituted (either by ammonia or by arginine), activity resulted, whereas if it was free the peptide was inactive.

The synthetic peptides studied were not nearly so potent as bradykinin, even though they did show activity. This may have been because of their striking difference in chemical structure from the natural compound, but may also have been related to the fact that the synthetics were larger than bradykinin. The synthetic peptides were disulphides, and the active ones were thus composed of 12 amino-acid residues, whereas bradykinin contains 8. One striking feature of active peptides related to strepogenin and to the melanophore-stimulating hormone has been that in each case an optimal size seems to be important for highest potency[1,5]. Whatever the merits of this question about size, the present results show clearly that for bradykinin, just as for strepogenin, oxytocin, etc., the exact chemical constitution of the naturally occurring peptide is not essential for biological activity, even though it may influence the potency quantitatively.

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Synthesis of Contractile Proteins in the X-Irradiated Embryo

In skeletal muscle the formation of actin precedes that of myosin in the early developmental stages of the chick[1,2] as well as *Triturus pyrrhogaster*[3], and in regenerating limb tissues of the latter[3]. The following questions therefore arose[4]: Does the formation of actin induce that of myosin and does it directly cause myosin formation? To obtain an answer to this question, the synthesis of contractile proteins in X-irradiated embryos of *Triturus pyrrhogaster* was examined by means of a serological technique[3].

G-Actin and myosin were prepared from large specimens of *Triturus pyrrhogaster* by the method of Straub and Szent-Györgyi[5]. Both proteins were injected intravenously (four times with 3-day intervals, 100 mgm. in total) into rabbits. The immunized rabbit sera were raised to their serological specificity by resorption test with saline extracts of liver, spleen and skin tissue of *Triturus pyrrhogaster*. Titration with homologous antigen was then carried out. The titre of both sera was adjusted to 1 : 512 before carrying out the precipitin reaction with saline extracts of X-irradiated embryos. Constant volumes of sera and progressively decreasing amounts of antigen were used in order to avoid an excess of antigen. The irradiation of embryos was carried out 108 hr. after fertilization under the conditions of Table 1.

Table 1. Irradiation Conditions

Dose of X-rays (r.)	kVp.	m.amp.	Filter	Target-object distance (cm.)	Intensity (per min.)
500	180	25·0	Cu (1·0 mm.) + Al (0·5 mm.)	28	167·6
200	,,	10·0	,,	,,	66·6
50	,,	2·5	,,	,,	16·7

In normal embryos, actin and myosin first became detectable 132 and 176 hr., respectively, after fertilization[3]. In the case of irradiation with 50 r., both actin and myosin were detected 156 hr. after fertilization. The time of actin and myosin formation after fertilization was changed to 180 and 144 hr., respectively, with 200 r., and to 204 and 132 hr., respectively, with 500 r., as shown in Fig. 1.

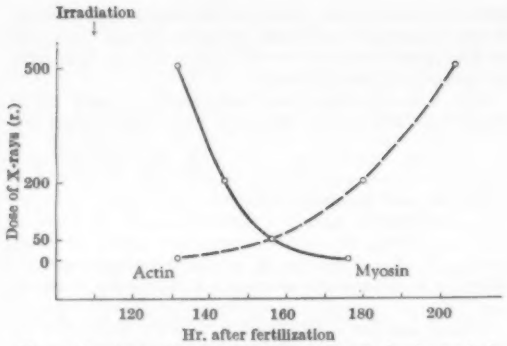

Fig. 1. Synthesis of contractile proteins in early development of the embryo of *Triturus pyrrhogaster* irradiated by X-rays 108 hr. after fertilization

X-irradiation 108 hr. after fertilization, therefore, markedly suppresses the synthesis of actin and promotes that of myosin in early developmental stages. The order of actin and myosin formation in the irradiated embryos at doses of 200 r. and 500 r. was opposite to that found in the non-irradiated control.

It was thus proved that during skeletal muscle differentiation in the early embryo of *Triturus pyrrhogaster*, the formation of actin does not induce that of myosin and the processes of synthesis of those proteins are independent of each other.

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Production of Shikimic Acid by *Penicillium griseofulvum* Dierckx

Several phenolic substances have been isolated from the cultures of *Penicillium griseofulvum* Dierckx: 2-hydroxy-6-methylbenzoic acid[1], 2,5-dihydroxybenzoic acid[2], *o*-, *m*- and *p*-hydroxybenzoic acid[2], 2,4-dihydroxybenzoic acid, 3,4-dihydroxybenzoic acid and 3,5-dihydroxybenzoic acid[4]. Those compounds, together with amino-benzoic acids[5], fulvic acid[6], griseofulvine[7] and patuline[8], were identified in metabolic solutions of cultures ten days of age or older. In order to detect substances which could be involved in the production of benzoic derivatives it seemed advisable to investigate the metabolic solution in the earliest stages of the culture. This has led to the identification of shikimic acid, which is interesting because of its possible conversion to phenolic substances such as has been shown for *Escherichia coli*[9]. Besides shikimic acid, sedoheptulose, *d*-erythrose and pyruvic acid have also been found. This communication describes the isolation and identification of shikimic acid and related substances.

Batches of 500 Erlenmeyer flasks of 500 ml. capacity each containing 100 ml. Czapek–Dox medium were aseptically inoculated with a suspension of *P. griseofulvum* (our strain *P* 34) and incubated at 25°. After 30 hr. the cultures were filtered through Chardin filter paper. The metabolic solution, having a *p*H of 5·8, was passed successively through a column of 'Dowex 50' (chloride) and then through a column of 'Dowex 2' (acetate). This last column was then washed with distilled water until sugar could no longer be detected, and after this washing it was eluted with a mixture of 50 per cent *N*/10 sodium acetate and 50 per cent *N*/10 acetic acid. The eluate was acidified to *p*H 3 by addition of *N*/10 hydrochloric acid and concentrated *in vacuo*.

The paper chromatography of this solution was carried out with Whatman paper No. 4 using four different solvents giving the following R_F:

	Shikimic acid	5-Dehydro-shikimic acid	5-Phospho-shikimic acid
n-Butanol–formic acid–water (50:2·5:10, v/v) (ref. 10)	0·43	0·46	0·09
n-Butanol–acetic acid–water (50:3:12·5) (ref. 10)	0·42	0·22	0·05
Phenol–water (3:1 w/v) (ref. 11)	0·44	0·48	0·11
*tert.*Butanol– benzyl. alc.–*iso*propanol–water (1:3:1:1, v/v) (ref. 11)	0·42	0·50	0·01

The reagents used were: (1) bromocresol green, (2) ammoniacal silver nitrate and (3) a succession of metaperiodate, nitroprussiate and piperazine. The chromatogram was then warmed to 105° C.[12].

These three reagents gave yellow spots for shikimic acid, 5-dehydroshikimic acid and for 5-phosphoshikimic acid. The identification of shikimic acid was also confirmed by co-chromatography with an authentic sample.

In order to obtain some information concerning the biosynthesis of shikimic acid the following experiments were carried out.

The mould was grown for 10 days at 25° in 500-ml. Erlenmeyer flasks containing 100 ml. Czapek–Dox medium. After having eliminated the culture solution, the mycelium felts were aseptically washed three times, each time with 100 ml. sterile distilled water. Then the preformed mycelium was left to act for 28 hr. at 25° on 100 ml. of one of the four following solutions: (1) *d*-erythrose 10^{-2} *M*, pyruvic acid 10^{-3} *M* and adenosine triphosphate 10^{-4} *M*; (2) *d*-erythrose, 10^{-2} *M*; (3) pyruvic acid, 10^{-3} *M*; (4) *d*-erythrose, 10^{-2} *M* and pyruvic acid 10^{-3} *M*.

After incubation the solutions were filtered and chromatographically analysed as described above. The results were that in solution (1) 5-dehydroshikimic acid and 5-phosphoshikimic acid were present while in solution (4) only traces of those substances could be detected and neither of them could be found in solutions (2) and (3).

Another series of experiments was made where *d*-erythrose was replaced by sedoheptulose. After 28 hr. incubation solution (1) contained only traces of 5-dehydroshikimic acid and of 5-phosphoshikimic acid and solution (4) contained none of either. But after 48 hr. incubation solution (1) contained more 5-dehydroshikimic acid and 5-phosphoshikimic acid, while in solution (4) traces of those two acids were detected.

Two other series of experiments were carried out with the same solutions but with shaken cultures. The results were exactly the same as those obtained with the ordinary cultures.

This is the first time that shikimic acid has been reported in mould metabolism. This substance seems particularly interesting owing to its probable place in the biosynthesis of the benzene ring which is present in many mould metabolites.

On the other hand, neither quinic acid nor dehydroquinic acid could be detected in the metabolic solution of *P. griseofulvum*, although those acids have been proved to play an important part in the synthesis of shikimic acid by *Escherichia coli*[13].

It is also worthy of note that shikimic acid is formed more readily by *P. griseofulvum* from *d*-erythrose + pyruvic acid + adenosine triphosphate than from sedoheptulose + pyruvic acid + adenosine triphosphate. This seems to suggest that in this case the biosynthesis of shikimic acid proceeds more easily via $C_4 + C_3$, while it has been shown for *Escherichia coli* that this biosynthesis takes place via sedoheptulose[14].

Finally, the comparison between the results obtained with solution (1) and with solution (4) points to the hypothesis that these phosphoric esters are directly involved in the synthesis, namely, *d*-erythrose-4-phosphate and phospho-enol pyruvic acid.

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Measurement of Transaminases in Serum

WITH the growing emphasis on the study of glutamic oxaloacetic and glutamic pyruvic transaminases of the serum, both in the diagnosis and the prognosis of a large number of pathological conditions, particularly in cardiovascular and hepatic diseases, a need for a simple and accurate method for the measurement of these transaminases is apparent.

A sensitive method has been devised which serves for the accurate and concurrent determination of the transaminases. This method can be used to assess the accuracy of earlier methods[1,3–5], and because of its simplicity it can be used easily as a routine method in clinical investigations.

The method involves the transamination by the serum of *dl*-alanine and α-ketoglutarate to glutamate and pyruvate (in the case of glutamic pyruvic transaminase) and of *dl*-aspartate and α-ketoglutarate to glutamate and oxaloacetate (in the case of glutamic oxaloacetic transaminase), in the following reaction:

$$R.CH.NH_2.COOH + R'CO.COOH \overset{(T)}{\rightleftharpoons} R.CO.COOH + R'CH.NH_2\,COOH$$

The measurement is based in the determination of the end-product of the transamination (pyruvate and oxaloacetate, respectively).

The substrates used are as follow:

(1) Glutamic pyruvic transaminase, 0·2 *M* *dl*-alanine and 0·002 *M* α-ketoglutaric acid: *dl*-alanine, 1·78 gm.; α-ketoglutaric acid, 0·03 gm.; dipotassium hydrogen phosphate, 2·00 gm.; distilled water to make up 100·00 ml.

(2) Glutamic oxaloacetic transaminase, 0·2 *M* *dl*-aspartic acid and 0·002 *M* α-ketoglutaric acid: *dl*-aspartic acid, 2·66 gm.; α-ketoglutaric acid, 0·03 gm.; dipotassium hydrogen phosphate, 2·00 gm.; distilled water to make up 100·00 ml. The reagents at the beginning are diluted to 80·00 ml. with water, adjusted to *p*H 7·4 with sodium hydroxide and made up to 100·00 ml. To each is added 1 per cent clear chloroform as a preservative. They can be kept in the refrigerator for many weeks, but should be discarded if they become cloudy or mouldy.

Other reagents used are: (*a*) aniline citrate: citric acid, 5·0 gm.; distilled water, 5·0 ml.; aniline, 5·0 ml.; the reagent is diluted before use 1 : 5 with distilled water; (*b*) dinitrophenylhydrazine 0·002 *M*: 2,4-dinitrophenylhydrazine, 0·04 gm.; conc. hydrochloric acid, 5·00 ml.; distilled water, 95·00 ml.; the reagent is diluted in the hydrochloric acid with 15–20 ml. water with vigorous shaking and made up to 100·00 ml.; (*c*) aqueous solution of 0·75 *M* sodium hydroxide; (*d*) pyruvic acid stock solution: pyruvic acid, 1·00 gm.; distilled water, made up to 1,000·00 ml.; it should be stored in the refrigerator.

To 0·8 ml. of serum saline in a test-tube add 0·2 ml. of serum with a pipette and mix the contents. 0·5 ml. of substrate for glutamic pyruvic or glutamic oxaloacetic transaminase is added and the tube is placed in a water-bath for 60 min. at 37° C. The tube is then held at room temperature and 0·5 ml. of the diluted citrate aniline is pipetted into it; this stops the enzymatic reaction. Immediately 0·5 ml. dinitrophenylhydrazine is added and the contents are vigorously mixed. Exactly 5 min. after the addition of the latter reagent (the time necessary to form pyruvate–dinitrophenylhydrazone but excluding the formation of α-ketoglutarate–dinitrophenylhydrazone), 3·0 ml. of sodium hydroxide are added, the contents are mixed by inversion of the tube and the colour produced is measured after 30 min. (the colour remains stable for 1 hr.), in a spectrophotometer at 500 mμ with a cuvette of 1 cm. diameter, against the blank set at zero optical density. The blank is a mixture of the reagents prepared in the same way as that of the sample, except that the serum is replaced with serum saline.

From the graph prepared with the use of known solutions of pyruvic acid (20, 40, 60 . . . 500 μgm./ml.) in the place of the serum and in the same quantity (0·2 ml.), after treatment of the tube as described, the pyruvic acid formed by the serum sample is determined directly in micrograms per ml. at 37° C., and for a period of 60 min. 1 unit is the amount of activity in 1·0 ml. of serum that results in the formation of 1 μgm. of pyruvate as defined by Cabaud *et al.*[1].

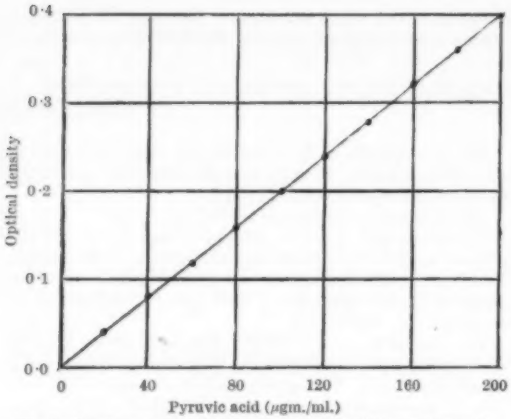

Fig. 1. Graph prepared with the use of known solutions of pyruvic acid, treated in the same way as the serum for glutamic pyruvic and glutamic oxaloacetic transaminase under the conditions described in the text. It is evident that linear relations exist between solutions of pyruvic acid from 0–200 μgm./ml. and the optical density produced and exhibited by them. The colorimetric measurement is made in a 'Unicam 600' spectrophotometer at 500 mμ with a cuvette of 1 cm. diameter

Fig. 1 indicates that the colorimetric reaction under the conditions of this technique follows closely Beer's law, up to the concentration of 200 μgm./ml. In the case in which the activity of the serum is very high, the determination is repeated with a sample of the serum diluted 1/5 or 1/10 with serum saline and the final result obtained is multiplied by 5 or 10.

An investigation of certain colorimetric methods for the estimation of transaminases in serum demonstrated the difficulties and inconveniences of some of the techniques. The methods described by Cabaud, Leeper and Wroblewski[1,2] and by Umbreit, Kingsley, Schaffert and Siplet[3] are characterized by the same principles as those of Tonhazy, White and Umbreit[4]. These methods are cumbrous. The deproteinization of the serum, the extraction by toluene and centrifugation require many manipulations. The separation of the toluene fraction is often difficult, and in many cases it forms a gelatinous mass and is obtained only after breaking it up and repeated centrifugations. On the other hand, the alkalinization of toluene requires the use of recently prepared solutions of alcoholic potassium hydroxide, which causes cloudiness of the mixture after the lapse of a few minutes.

In comparison with the previous methods, the method of Reitman and Frankel[5] is exceptionally easy and simple. Experience shows, however, that the method is unsatisfactory, because of its particular characteristics; for the colorimetric determinations of the end product (pyruvate and oxalate) formed are made by the use of a graph of mixed solutions of the pyruvic and α-ketoglutaric acids, in an empirical way.

It is evident that the method described is considerably simpler, requiring the use of a test-tube only for the transamination reaction and for the determination of the pyruvate produced. In addition it is accurate, because the end products, pyruvate in the case of the glutamic pyruvic transaminase, and the resulting pyruvate by decarboxylation of oxaloacetate by the use of citrated aniline in the case of glutamic oxaloacetic transaminase, are both calculated directly by the use of a prepared graph on the basis of known solutions of pyruvic acid. The method is also very sensitive. The greatest error found among the replicates of a considerable number of normal and pathological sera was approximately 2·5 per cent.

In 50 presumably healthy individuals of ages ranging from 20 to 40 years the range of values for glutamic pyruvic and glutamic oxaloacetic transaminase was found to be 15–98 and 26–92 units per ml. of serum determined at a temperature of 37° C., and for a period of 60 min. Thus readings above 100 units per ml. indicate pathological conditions.

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Conjugation of 3 : 4-Benzpyrenols in Mouse Skin

The liver is undoubtedly the major site of glucuronide synthesis in the mammal[1,2], but varying degrees of glucuronide synthesizing activity have also been reported for other tissues. These include the kidney[1,2], intestine[3], cartilage[4] and granulation tissue[5], although the findings of different workers have not always been in agreement. The only specific investigation of this nature which we have been able to find applied to such activity in skin is that of Zini[6], who reported that isolated rat skin possesses 'some' glucuronide synthesizing activity with *o*-aminophenol as substrate. No quantitative details are given, but the assumption is that the level of activity falls far below that of other tissues in which significant activity was observed. Evidence from another field, however, would suggest that the glucuronide synthesizing ability of skin may be by no means insignificant and indeed may play an important part in the detoxification of foreign substances at that site. Thus it is now well confirmed that the carcinogenic hydrocarbon, 3 : 4-benzpyrene, is metabolized in mouse skin both *in vivo*[7–9] and *in vitro*[10] to yield a water-soluble polar derivative designated as BPX_2 (ref. 7). Subsequent work by one of us (K. H. H.) has shown this metabolic fraction to consist of a mixture of glucuronide conjugated benzpyrenols[11]. The analogous sulphate conjugated fraction[11], on the other hand, has not so far been detected within the skin, and this has led one of us (G. C.) to suggest that the formation of this complex (BPX_1) is divorced from the carcinogenic response elicited by 3 : 4-benzpyrene at this site[8]. It was of importance, therefore, to re-examine the conjugating ability of mouse skin in the light of this evidence.

Mice, in batches of about twenty, were closely clipped or plucked and in parallel experiments a solution of either 3 : 4-benzpyrene or the phenol, 8-benzpyrenol, in acetone was applied to the denuded areas of skin. After varying intervals of time the animals were killed and the treated areas of skin removed, minced and homogenized. Extraction and separation into glucuronide and sulphate conjugated fractions were then carried out using a modified form of the original method of Weigert and Mottram[7]. Details of this have been published elsewhere[11].

The experiments with 3 : 4-benzpyrene confirmed the findings of other workers with regard to the formation of benzpyrenyl glucuronides within the skin although the concentration at any time was found to be low. Identical behaviour was observed in the parallel experiment with the phenolic derivative 8-benzpyrenol, for, although the glucuronic acid ester was readily detected in the extracts, the total amount present at any time was of the same order as that yielded by the parent hydrocarbon. This suggests that the initial hydroxylation of benzpyrene is not a limiting factor in determining the concentration of conjugated metabolites within the skin.

Throughout these experiments evidence was also sought of conjugation with sulphuric acid. Trace amounts of a metabolite possessing the physical properties of a benzpyrenyl sulphate were isolated after treatment with both 3 : 4-benzpyrene and 8-benzpyrenol, but the small amount obtained prevented an unequivocal identification. *In vitro* studies with microsome-free supernatant fraction of skin homogenate fortified with adenosine triphosphate, as described by De Meio, Wizerkaniuk and Fabiani[12], yielded inconclusive results.

The conclusion arrived at from this work, therefore, is that mouse skin does possess the ability to conjugate foreign phenolic compounds with glucuronic acid and possibly sulphuric acid. To what extent this occurs, however, is as yet unknown, for these experiments do not preclude the possibility that the conjugates are either rapidly removed from the skin via the blood stream or perhaps bound firmly to cellular constituents. The additional point also arises that hydroxylation of aromatic hydrocarbons can occur within the skin although no evidence exists as yet as to the mechanisms involved.

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Heterogeneity of Tumour Ribonucleic Acid and the Effect of 'Degranol' on it

In view of its importance to the study of the chemical properties and specific biological functions of nucleic acids, in recent years much attention has been devoted to the heterogeneity of this group of compounds[1–4].

In earlier papers[5,6] we reported the elaboration of a new method and the results obtained with it in a study of the heterogeneity of ribonucleic acid obtained from rabbit liver and labelled with phosphorus-32 *in vivo*.

The present communication describes the heterogeneity of ribonucleic acid obtained from Guérin carcinoma transplanted into rats and labelled with phosphorus-32 *in vivo*; further, the effect on this heterogeneity of 1,6-*bis*-(-β-chloroethylamino)-1,6-deoxy-D-mannitol-dihydrochloride ('Degranol'; B.C.M.)[7].

Inbred albino rats weighing 120–150 gm. were inoculated subcutaneously with Guérin carcinoma, and divided into two groups. One group was given intravenously a 50 mgm./kgm. dose of 'Degranol' 14–16 days after the transplantation of the tumour, and the other was left untreated. The animals received a 100 μc./100 gm. intraperitoneal dose of phosphorus-32 at 48 hr., and were decapitated at 72 hr. after 'Degranol'. Each of the resultant tumours was worked up separately and the ribonucleic acid was recovered from the whole tumour by the method of Pain and Butler[8], modified inasmuch as the ribonucleic acid precipitated by the addition of 96 per cent ethanol was dissolved in 0·2 *M* sodium chloride and dialysed for 24 hr. at + 4° C. against 0·2 *M* sodium chloride. A quantity of 6–10 mgm. of ribonucleic acid was adsorbed on a 6 cm. × 1·5 cm. 'Dowex-2' resin column (Cl-form, 10 per cent cross-linkage, 200–300 mesh) and eluted with sodium chloride solutions of continually increasing concentration. The reservoir contained 2·8 *M* sodium chloride, and the 225-ml. mixing flask, initially, 0·3 *M* sodium chloride. The rate of flow was 0·25 ml./min. 5-ml. fractions were collected, and aliquot parts of these were used to determine radioactivity and ribonucleic acid content, the latter by the orcinol reaction as modified by Ceriotti[9].

Fig. 1 shows that the ribonucleic acid isolated from whole tumour is heterogeneous; moreover, that the individual fractions of ribonucleic acid differ in specific activity. This difference permits the conclusion, which is consistent with that drawn from our earlier heterogeneity studies of rabbit liver ribonucleic acid[6], that in the living organism the phosphorus-32 exchange in the individual ribonucleic acid fractions proceeds at different rates.

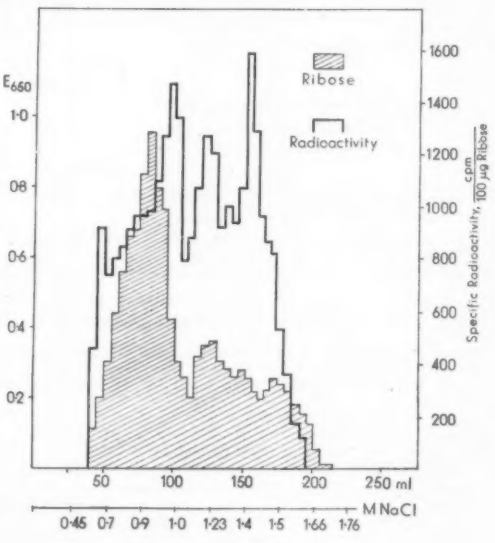

Fig. 1

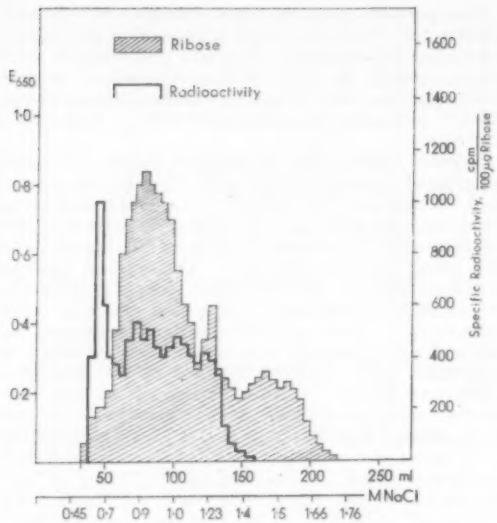

Fig. 2

Kellner *et al.*[10,11] have shown that morphologically the peak effect of 'Degranol' appears between 48 and 72 hr. after treatment, manifesting itself in extensive cellular and nuclear disintegration in the florid parts of the tumour. Hidvégi *et al.*[12,13] have observed a substantial decrease at that same period of time in the relative specific activity of the phosphorus-32 in the deoxyribonucleic acid, and a less notable, but still significant, fall in the ribonucleic acid of the nuclei and the cytoplasma. For these reasons, in our experimental animals we have studied the heterogeneity of the tumour ribonucleic acid at 72 hr. after 'Degranol', when the drug has been established to exert its maximum effect.

On the evidence of Fig. 2, 'Degranol' causes no change in heterogeneity in ribonucleic acid but does give rise to essential differences in the incorporation of phosphorus-32. Appreciable radioactivity was only measured in fractions which could be eluted at lower sodium chloride molarities.

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ANIMAL PHYSIOLOGY

Effects of 1,4-Dihydrazinophthalazine on the Catechol Amines

In a previous communication in *Nature*[1] some effects of 'Nepresoline' on the catechol amines in various organs of rats and on the adrenal medullary secretion in cats were described. Further experiments using chiefly the same technique have been carried out.

A total of 165 male albino rats with an average body-weight of 250 gm. were divided into groups of five and injected with 5–50 mgm./kgm. 'Nepresoline' subcutaneously twice a day on three consecutive days. The control groups were given an equivalent amount of vehicle. The rats were killed with a blow on the head on the first, third and fifth day after the last injection, respectively. The content of adrenaline and noradrenaline in adrenals, brain, heart and spleen was determined fluorimetrically after purification by absorption on aluminium oxide. All values were measured in µgm./gm. organ weight.

The effect of intravenous injection of 5 mgm./kgm. 'Nepresoline' on the secretion from the left adrenal after sectioning the corresponding splanchnic nerve was studied on 5 cats weighing 3–4 kgm., anæsthetized with 'Nembutal' (40 mgm./kgm. intraperitoneally). In one case the spinal cord was divided at *C* 1.

Venous blood from the left adrenal was collected at intervals before and after giving 'Nepresoline', using an adrenolumbar-femoral vein shunt technique. The adrenal vein plasma samples were assayed biologically on the cat's blood pressure and the hen's rectal cæcum.

In the rats, a dose of 5 mgm./kgm. caused in some experiments a marked depletion of noradrenaline in heart and adrenal. However, this effect was irregular. With higher doses of 'Nepresoline' a definite reduction of the content of both adrenaline and noradrenaline in the adrenals was found. With a dose of 50 mgm./kgm. a low level of noradrenaline was occasionally found in the brain. The only organ which showed complete regularity in response was the adrenal (Table 1).

Table 1. Mean Values for Catechol Amine Content of the Rat's Adrenal after Various Doses of 'Nepresoline'
The corresponding values for controls, injected with an equivalent amount of solvent, are given within brackets

'Nepresoline' dose	Adrenaline µgm./gm. organ	Adrenaline per cent of control values	Noradrenaline µgm./gm. organ	Noradrenaline per cent of control values
10 mgm./kgm.	578 (803)	71	118 (137)	86
50 mgm./kgm.	266 (680)	39	77 (137)	56

In cats, after adrenal denervation, 'Nepresoline' caused a much less definite secretory response than was found in cats with intact innervation. In one case no response was seen, whereas in four cats a slight stimulation of the medullary secretion occurred. In the spinal cat preparation, no definite increase in the secretion was found.

The effects of 'Nepresoline' on various organs in rats show a surprising and disturbing variation. However, it seems that, if fairly high doses are used, consistent reduction of the amount of adrenaline and noradrenaline in the adrenal was found.

As mentioned in the previous communication, low noradrenaline values were found for the heart after 'Nepresoline'. This effect we have not been able

to confirm in more recent experiments. In the brain, after higher doses of 'Nepresoline', a reduction of the noradrenaline-level occurred occasionally. The variability in the response of these organs to 'Nepresoline' remains unexplained.

The results of the cat experiments suggest that the effect of 'Nepresoline' on the adrenal secretion is mainly mediated through the nervous system. In our previous report it was mentioned that baroreceptor denervation by vagotomy and carotid sinus denervation did not abolish the response. Thus it seems likely that the effect is not reflexly elicited by fall of blood pressure, but is due rather to the direct action of 'Nepresoline' on some structure in the central nervous system and possibly to some extent on the adrenals.

Further experiments to elucidate the mechanism of the 'Nepresoline' effects on the adrenal are in progress.

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Diurnal Temperature Variation in the Rhesus Monkey under Normal and Experimental Conditions

A DIURNAL temperature variation has been previously reported[1] in the unrestrained rhesus monkey (*Macacca mulatta*) the confirmation of which was the object of the present study. An accurate estimate of diurnal temperature variation is a necessary prerequisite for assessing basal body-temperature in this species.

Temperature recordings were made routinely with a clinical thermometer per vaginam in nine mature female rhesus monkeys which had become accustomed to handling in a previous study[2]. The monkeys during the control period were kept one to a cage, in quarters previously described[3] in which ambient temperature and humidity conditions were held constant and artificial lighting (virtually the only source of illumination) was controlled. Lights were on during 8 a.m.–4 p.m. each day, preceded and followed by dawn and dusk, night-time (near total darkness) intervening.

Temperature recordings were made at 10 a.m., 1.30 p.m., 5 p.m., and 10 p.m. over a period of one month. The former two temperature recordings were made in artificial illumination, the latter two recordings under conditions of near total darkness.

As previously observed[1], if a monkey was inclined to struggle during handling, its temperature slightly increased. If the monkey was purposely stressed by being chased, a temperature increase of 1° F. promptly occurred. With repeated recordings, the monkeys became acclimatized, and temperature values obtained were not believed to be due in part to incidental struggling.

In 6 of the 9 animals studied, the mean temperature values (and associated standard deviations) over the 12-hr. period of recording are plotted individually (Fig. 1). The range of the temperature variation under the control or normal condition in each animal is given in the upper right-hand corner of the respective graph and is plotted along a 24-hr. abscissa in a solid black line. The number of recordings upon which the control or normal variation is based is indicated in the upper right-hand corner under the value of the range.

The highest temperatures recorded were obtained usually in the early afternoon, the lowest temperatures at 10 p.m., about 5 hr. after the onset of near total darkness.

The animals were further studied for 3 months in an isolated, light-tight environment in which temperature and humidity conditions of the control period were maintained and held constant, but lighting conditions altered. Periods of 14 hr. of total darkness were followed by periods of 16 hr. of bright light. This 30-hr. dark-light period, and the relative absence of daily noise were the two most marked differences between the control and experimentally modified environmental conditions.

In the experimental environment, temperatures were recorded at the approximate midpoint during the light period, and at 5 and 10 hr. after the onset of total darkness. Temperatures were recorded in the total darkness in the light-tight experimental environment by first darkening the ante-chamber before entering the totally darkened room, so that recordings could be made with minimal disturbance to the animals.

The variation in temperature encountered in the experimental environment is plotted individually (dotted lines, Fig. 1), and in the upper right hand corner of each individual graph is the number of

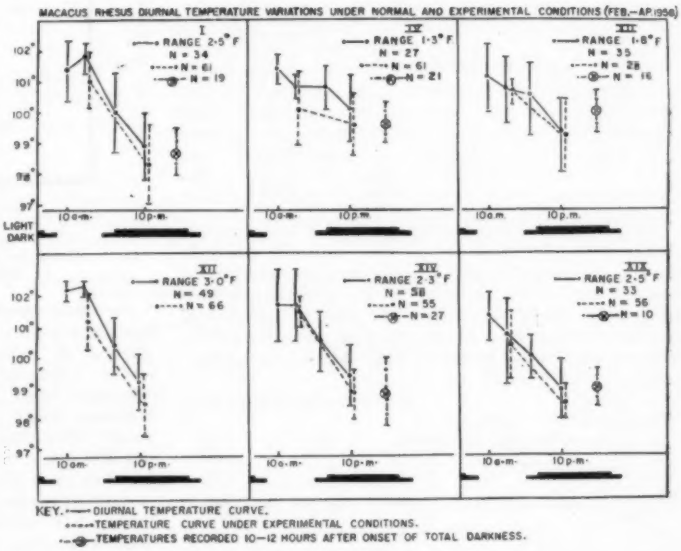

Fig. 1

recordings upon which the experimental temperature variation is based.

The temperature-range over the 30-hr. light-dark period has been plotted in terms of the 24-hr. time-base of the control environment to make similar periods of temperature recordings comparable. It may be noted that the temperatures in the experimental environment, both at the midpoint of the light period and 5 hr. after the onset of total darkness, were of the same approximate magnitude, but in all cases somewhat less than those encountered at comparable times diurnally, so that similar slopes between diurnal and experimental temperature curves resulted when the values were plotted.

In order to ascertain the period of greatest temperature depression in the experimental environment, temperature recordings were made at both 5 and 10 hr. after the commencement of total darkness. The latter mean temperature value (based on the number of recordings indicated in the upper right-hand corner of individual graphs) has been plotted in 5 of the 6 animals studied. In 4 out of 5 of these animals, mean temperatures 10 hr. after the onset of total darkness were slightly higher than the temperatures occurring 5 hr. after the onset of total darkness, but less than temperatures recorded in the light. In the fifth recorded animal (XIV, Fig. 1) the mean temperature value 10 hr. after the onset of darkness was the same as that occurring 5 hr. earlier.

The slight, but systematic reduction in temperatures in the experimental environment compared with diurnal values can be explained in two possible ways: (1) the relative absence of diurnal noise, and (2) the fact that the monkeys were out of sight of other monkeys of the main colony room, the isolation from which deprived them of sensory stimuli. The fact that depressed temperatures 5 hr. after the onset of total darkness in the experimental environment were less than those recorded diurnally may be due to the condition of total darkness achieved experimentally, but not achieved during the control night-time periods.

Table 1

Animal				Temperature (° F.)
XIII	*Macacca*	*mulatta*	female	3·0
I	,,	,,	,,	2·6
XIX	,,	,,	,,	2·5
XIV	,,	,,	,,	2·3
III	,,	,,	,,	2·1
XII	,,	,,	,,	1·8
X	,,	,,	,,	1·7
IV	,,	,,	,,	1·3
			Mean:	2·16
			S.D.	1·47

Table 1 illustrates the range of diurnal temperature variation encountered in the nine animals studied. The diurnal range in two *Macacca mulatta* previously studied[1] was of the order of 3° F., a finding which the present study confirmed. It may be concluded that the diurnal range in temperature variation in the *Macacca mulatta* is largely a light-dependent phenomenon.

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Body-weight and Liver —SH Levels of Mice

During the course of some recent work[1] the —SH levels of the liver tissue of groups of mice were determined. In any one group (10 animals) most figures fell very close to the mean figure, but an occasional case occurred showing a considerable divergence from the mean. The impression was gained that those animals whose liver —SH diverged most from the mean figure were either the smallest or largest in any group. This point has now been checked experimentally and the findings are presented below.

A batch of twenty inbred 'Strong *A*' mice of 12 weeks age were taken. Apart from this selection on an age basis no further selection was undertaken. The animals were treated individually and for each one the total body-weight and total liver (less gall bladder) weight were recorded. Using slices from the liver (85–140 mgm.) the —SH content was determined by the method described by Calcutt and Doxey[2]. The —SH content was calculated as a value per 100 mgm. wet weight of liver and also as total liver content. No correlation whatever was detectable between the total body-weight and liver-weight or between total body-weight and total liver —SH. However, a plot of total body-weight against the —SH value per 100 mgm. of liver (wet weight) appeared as in Fig. 1. The apparent inverse relationship between body-weight and —SH per unit mass indicated by this figure is in keeping with the impression gained in earlier work as —SH values were calculated on a unit mass basis during those experiments.

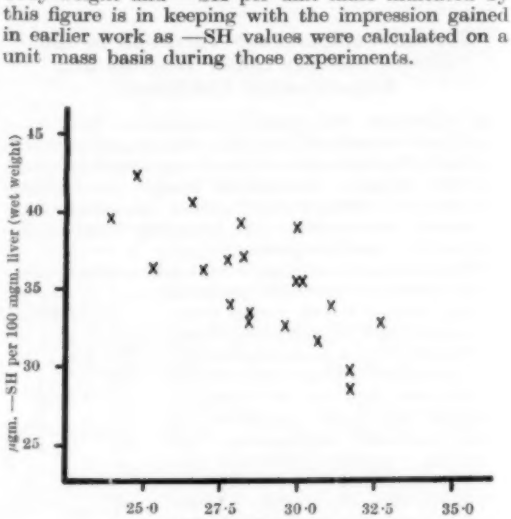

Fig. 1. —SH per 100 mgm. of liver (wet weight) against total body-weight. 'Strong *A*' males

As confirmation of these findings a parallel experiment has been carried out using a batch of 20 female 'Strong *A*' mice. The age of this group was 20 weeks. Once again no correlation could be determined between total body-weight and liver-weight, or between total body-weight and total liver —SH level. The plot of body-weight against liver —SH per 100 mgm. wet weight of liver is shown in Fig. 2. In this case the body-weights fell within a more restricted range than in the case of the males and the liver —SH values showed a wider scatter. Nevertheless, a similar inverse relationship between body-weight and —SH level per unit mass is apparent.

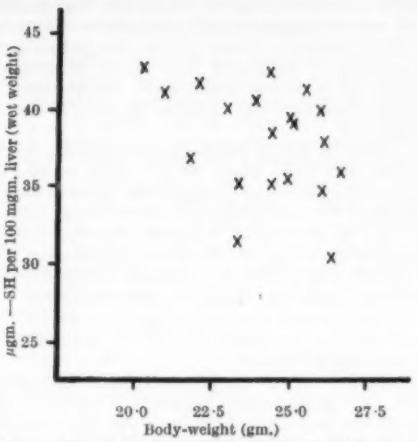

Fig. 2. —SH per 100 mgm. of liver (wet weight) against total body-weight. 'Strong *A*' females

The relationship found in the above experiments is a rather puzzling one and the only suggestion to explain it is the following. Unit masses of the various livers from any one group of animals contain approximately equal numbers of cells and it is the —SH level per cell which varies inversely with body-weight. Since the cell is a balanced biochemical system these findings suggest that other cell constituents may also vary in level according to body-weight. Such a consideration leads to the conclusion that, for biochemical work involving measurements of small differences, all animals used should be carefully selected on the basis of both age and weight.

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Essential Fatty Acids of Normal and Atherosclerotic Aortas from Chickens receiving Differently Saturated Fats for Three Years

Sinclair's suggestion[1] that atherogenesis may be associated with a relative essential fatty acid deficiency has received considerable attention in many laboratories. On the basis of fatty acid analyses of atheromatous plaques, several investigators have concluded that Sinclair's hypothesis is not substantiated[2,3]. Very recently, Sinclair[4] has joined issue with those who drew these conclusions by suggesting that the fatty acid analytical techniques employed do not differentiate between the essential fatty acids (linoleic and arachidonic) and non-essential fatty acids of similar unsaturation. Although in the present study no attempt was made to differentiate between linoleic and arachidonic acid on one hand, and other di- and tetra-enoic acids on the other, the results herein presented may contribute to a better understanding of the relationship between essential fatty acids and plaque formation.

Three groups of 12-week old Leghorn pullets were fed for three years on : (1) a standard low fat laying ration ; (2) the same ration supplemented with 10 per cent corn oil ; or (3) supplemented with 10 per cent animal tallow. After killing the hens at the end of three years on the above diets the aortas were removed from the heart to the iliac bifurcation, cleaned of adhering tissue and visually scored[5]. Since significant plaque formation affects primarily the abdominal region of the aorta only this segment was used for the fatty acid analyses. From each of the three fat treatment groups four abdominal aortic segments with the severest atherosclerotic involvement (out of a total of 15–17 per group) were carefully dissected into plaque and clear areas. Lipids were extracted with chloroform/methanol (2 : 1) from the pooled plaque and clear tissues as well as intact abdominal segments from the three treatment groups showing little or no atherosclerotic involvement, the extracts filtered and analysed for iodine numbers and polyunsaturated fatty acids by the methods of Luddy *et al.*[3] and of Morris and Riemenschneider[6].

The results of these analyses are shown in Table 1. It can be seen that in all but one instance the di- and tetra-enoic fatty acid concentration of the lipids from the plaque areas was lower than for the clear areas from the same aortic segments. However, even the concentration of these fatty acids from the clear areas was lower than for the non-affected abdominal segments. Table 1 further shows that there is an inverse relationship between the severity of the atherosclerotic involvement (visual score) and the level of essential fatty acids in the plaque tissue. While these observations lend support to Sinclair's original suggestion, the fact that considerable atherogenic development occurred even in the birds fed with corn oil the aortas of which contained a comparatively high essential fatty acid concentration, would strongly suggest that plaque formation does not owe its origin to an essential fatty acid deficiency.

Table 1. Fatty Acid Composition (per cent) of Lipid Extract from Abdominal Aortas of Chickens fed Differently Saturated Fats for Three Years

Fatty acids	Abdominal aortic tissue								
	Unaffected			Affected					
				Plaque area			Clear area		
	No fat	Corn oil	Animal fat	No fat	Corn oil	Animal fat	No fat	Corn oil	Animal fat
Saturated	56·9	56·2	51·6	74·2	54·9	50·1	56·5	46·3	45·5
Monoenoic	26·9	14·7	35·0	17·8	27·1	35·6	30·7	33·0	42·3
Dienoic	*12·0*	*22·2*	*10·3*	*6·2*	*15·5*	*11·4*	*10·1*	*17·4*	*9·7*
Trienoic	0·9	1·2	0·9	0·7	0·9	1·2	1·0	0·9	0·7
Tetraenoic	*1·5*	*1·6*	*1·5*	*0·6*	*1·0*	*0·9*	*1·0*	*1·8*	*1·0*
Pentaenoic	0·2	0·2	0·2	1·0	0·1	0·2	0·2	0·2	0·2
Hexaenoic	0·5	0·5	0·5	0·4	0·5	0·6	0·4	0·4	0·6

Visual scoring : 1 = unaffected ; 6 = most severe involvement. Scores for the affected abdominal aortas were : No fat, 3·0 ; corn oil, 2·2 ; animal fat, 2·3.

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HÆMATOLOGY

Elevation of Serum Haptoglobin in Rabbits in Response to Experimental Inflammation

Normal human serum contains sufficient haptoglobin to bind approximately 130 mgm. of hæmoglobin per 100 ml. (ref. 1). A number of other mammalian species, including the rabbit, have much lower serum haptoglobin-levels[2]. In order to have available a plentiful source of rabbit haptoglobin a method was sought by which the normal serum level could be elevated. Observations on patients with various diseases suggested that tissue inflammation might provide a means to this end[3]. Accordingly, the effect of administering turpentine to rabbits was investigated.

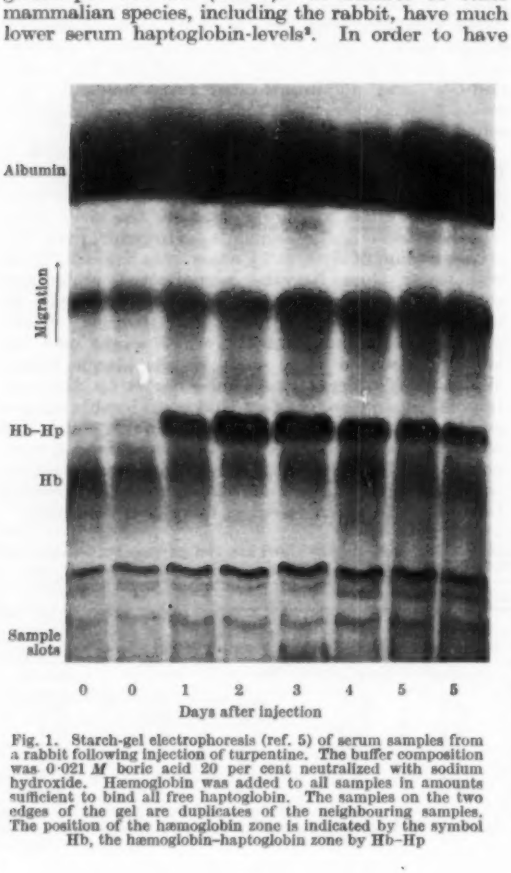

Fig. 1. Starch-gel electrophoresis (ref. 5) of serum samples from a rabbit following injection of turpentine. The buffer composition was 0·021 *M* boric acid 20 per cent neutralized with sodium hydroxide. Hæmoglobin was added to all samples in amounts sufficient to bind all free haptoglobin. The samples on the two edges of the gel are duplicates of the neighbouring samples. The position of the hæmoglobin zone is indicated by the symbol Hb, the hæmoglobin–haptoglobin zone by Hb–Hp

The range of serum haptoglobin concentration[4] in 32 rabbits was 2–35 mgm. with a mean of 10 mgm., expressed in milligrams hæmoglobin-binding capacity per 100 ml. Fifteen rabbits of various ages received a 1-ml. dose of turpentine injected subcutaneously in the dorsolumbar region. In these animals the serum haptoglobin concentration increased to 150–300 mgm. per 100 ml. The rise began at approximately 12 hr. after injection and reached a peak at 48 hr. The level afterwards decreased and fell to one-half of the maximum in 2½–3 days.

The changes in starch gel electrophoretic pattern[5] following turpentine injection are illustrated in Fig. 1. Although the increase and subsequent decrease in the hæmoglobin–haptoglobin zone is the most striking feature, there are changes in several other zones, particularly in those migrating between albumin and the hæmoglobin–haptoglobin complex. Analysis of serum samples for total protein-bound carbohydrate[6] and total protein[7] were also performed. Serum glycoprotein concentration doubled during the initial 48 hr. after injection. More than half the increase of the serum glycoprotein at 48 hr. could be attributed to haptoglobin. No appreciable changes in the total serum protein level were observed.

Whether the rise in haptoglobin represents net synthesis or liberation of pre-formed haptoglobin has not been elucidated. The site of synthesis or of liberation also remains unknown. However, it is unlikely for the following reasons that the haptoglobin is released into the blood at the site of injection: (1) the haptoglobin-level of exudate withdrawn from the site of injection at 24 and 48 hr. was found to be much lower than the haptoglobin-level of serum; (2) the injection of 2·0 *N* hydrochloric acid which caused local ulceration failed to produce marked elevation of serum haptoglobin; (3) when repeated daily injections of turpentine were administered to one rabbit at different sites, the maximum level of haptoglobin and the rate of disappearance were within the limits observed when only a single dose was given. These observations suggest that a tissue pool of haptoglobin may exist normally, possibly in the liver, and that the protein is released into the blood stream in response to inflammation.

This work was supported by a grant from the National Research Council of Canada. One of us (R. K. M.) holds a Graduate Medical Research Fellowship of the National Research Council of Canada.

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Effect of Manganese Edetate on Blood Formation in Rats

IT has been reported by Sullivan[1] that anæmia developed in immature rats fed on a diet containing those metallic complexes of edetic acid having stability constants lower than ferrous iron, the anæmia being preventable by simultaneous iron injections. Other authors[2–4] had reported that these complexes given to adult rats orally or by injection produced no alteration of the blood picture compared with controls. It seemed probable therefore that the chelates were capable of producing an iron deficiency anæmia in immature rats but less readily or not at all in adult animals, and this problem has been further investigated.

Control and treated groups of rats were matched according to age and sex, and received a diet of powdered rat cubes with water to drink *ad lib.* Treated rats received, in addition, 4 per cent manganese edetate in the diet. This complex has a stability constant slightly lower than ferrous iron, which it would thus be expected to chelate, but somewhat higher than complexes formed by sodium, magnesium and calcium, so that any abnormalities in treated rats due to deficiency of these cations would be avoided. Blood for investigation was obtained either by amputating the tip of the tail or by decapitation under ether anæsthesia.

Table 1 shows the results obtained. Group 1 consisted of adult rats treated for 50 days. Although there was a significant difference between the hæmoglobin values of control and treated rats, those of the treated animals were only slightly reduced, and no other abnormalities in the blood picture were discovered.

Groups 2 and 3 consisted of young immature rats which were treated for 50 and 40 days respectively. The hæmoglobin values of treated animals were much lower than controls in both groups, particularly in the more immature rats in group 3. The red cells of treated rats in group 2 were microcytic. The mean corpuscular hæmoglobin concentration of treated animals in group 3 was significantly lower and the blood film confirmed a hypochromic anæmia.

After 50 days treatment with manganese edetate, rats in groups 1 and 2 were returned to a normal diet for 30 days. Blood investigations were then repeated, and no significant differences between treated and control rats remained.

In these experiments, a severe but reversible iron deficiency anæmia was produced among immature but not adult rats. The more immature the rats, the more severe was the anæmia. Previous results[1] indicate that this effect can be produced by many heavy metal chelates less stable than ferrous edetate. There are reports that manganese may affect blood formation but these are contradictory[5].

All animals gained weight, although the gain of treated rats in group 3 was poor compared with their controls. Taste cannot be excluded as a cause for this since rats were not pair-fed. This group of rats also differed from the others in that they had just been weaned.

I wish to thank Prof. R. S. Stacey and Dr. M. S. R. Hutt for advice and assistance, and Dr. J. K. Aiken of the Geigy Co., Ltd., Manchester, for supplies of manganese edetate.

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Rivanol in the Preparation of Plasminogen (Profibrinolysin)

THE most commonly used technique for preparing plasminogen is that worked out by Kline[1] using fraction III as a starting material. Plasminogen seems to be a rather resistant protein, for extreme *p*H's are used in the above-mentioned method. It would be interesting to compare the profibrinolysin prepared by the Kline technique with a product obtained by a completely different method.

Rivanol (diamino-ethoxyacridine lactate) has been used for the preparation and purification of several plasma proteins such as γ-globulin[2], β_1-metal combining globulin[3], ceruloplasmin[4], haptoglobin[5] and thrombin[6]. So we were interested to study the behaviour of plasminogen during subfractionation of fraction III by rivanol.

The fibrinolytic activity of each sample obtained after streptokinase activation ('*SK* Diamant') is measured by a technique using purified and relatively plasminogen-free fibrinogen (Kekwick *et al.*[7]) and thrombin (unpublished) preparations following the technique of Kowalski *et al.*[8]. Small concentrations of rivanol do not interfere with the detection of fibrinolytic activity. Samples freed of the acridine derivative by treatment with charcoal at *p*H 8·5 showed almost the same activity.

Ceruloplasmin can be prepared, as recently described[4], by treating fraction III with rivanol. We found that plasminogen is precipitated together with ceruloplasmin as revealed by the screening test for fibrinolytic activity.

The rivanol–protein complex obtained in step 2 is dissociated at *p*H 4 and 50 per cent alcohol concentration. The precipitate is then extracted by acetate buffer 0·5 *M*, *p*H 6·5 (final *p*H 5·9). This solution

Table 1. BLOOD INVESTIGATIONS ON RATS RECEIVING 4 PER CENT MANGANESE EDETATE IN THE DIET, COMPARED WITH CONTROLS. FIGURES ARE GIVEN IN ITALICS WHERE $P < 0.05$

Groups	No. of rats	Mean initial body-weight (gm.)	Weight increase (per cent)	Hæmoglobin (gm./100 ml. blood)	MCHC	Red blood cells (millions/cu. mm.)	MCV (cu. μ)
(1) Controls	5	247	3	15	31	8·53	58·5
Treated	5	242	9·5	*13·4*	30	7·57	59·5
(2) Controls	5	52	213	14·5	30	8·59	57
Treated	5	51	184	*9·9*	28	8·25	*41·5*
(3) Controls	4	34	305	13·6	31	—	—
Treated	6	34	104	*7·7*	*26*	—	—

MCHC, Mean corpuscular hæmoglobin concentration; MCV, mean corpuscular volume.

contains ceruloplasmin but has no fibrinolytic activity. The plasminogen is not destroyed and is still present in the bulk of denatured proteins. Plasminogen is more soluble in dilute salt solutions and so we treated the precipitate remaining after the extraction of ceruloplasmin by dilute saline at *p*H near neutrality.

This saline extract freed from rivanol by treatment with charcoal at *p*H 8·5 is highly active as shown by fibrinolytic activity tests.

Further work is in progress and will be published elsewhere.

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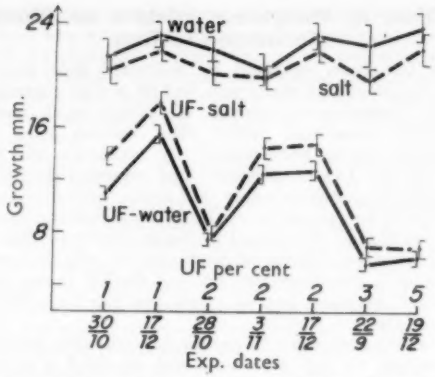

Fig. 2. Growth of roots in water and salt solutions with or without addition of an ultra-filtrate of denatured serum in six independent experiments (two ordinate values are partially common in one experiment (December 17, 1958)). Ordinates: growth in mm. in 24 hr. at 15° C.; abscissæ: (1) dates of experiments (1958), (2) percentage (v/v) of ultra-filtrate (*UF*) in water or salt solution in two lower curves. Ultra-filtrate of serum from various probands, freshly taken the day before each experimental date. Vertical transverse lines on curves: 95 per cent fiducial limits

PLANT PHYSIOLOGY

Specific Interaction of Native Protein and Inorganic Salts

Under the action of certain inorganic salts, native serum proteins release a phytohormonal fraction inhibitory to the growth of plant roots, as may be seen by comparing Fig. 1 with Fig. 2.

Fig. 1 shows the average increment in millimetres in 24 hr. of roots of *Lupinus albus* (the Macht–Livingston technique[1]) grown in nutrient solutions containing five different concentrations of serum in five independent experiments, that is, one with each concentration of serum. The nutrient solutions were made up of 1–10 per cent serum (v/v) diluted partly with water and partly with a well-balanced triple-salt solution consisting of 2·5 m*M* calcium nitrate, 7·5 m*M* magnesium sulphate and 9·0 m*M* potassium dihydrogen phosphate (after Shive[2]). The serum originated from five different samples of blood, one for each experiment, taken from the same proband.

The curve marked 'water' in Fig. 1 shows the increment in distilled water, while that marked 'salt' indicates the increment in the triple-salt solution. As previously demonstrated by Ekdahl[3] and by me[1], in a 24-hr. experiment in water the increment is greater or of the same order as in the triple-salt solution. The vertical transverse lines on the curves indicate fiducial limits at the 5 per cent level (variation within experiments).

The curves marked 'serum–water' and 'serum–salt' show the growth in water and in the triple-salt solution, respectively, with serum added at the concentrations indicated on the axis of abscissæ. The curves marked 'serum–water' and 'serum–salt' are at a lower level than the 'water' and 'salt' curves, indicating that serum causes reduced growth of the roots.

Fig. 1 thus clearly shows two effects, namely, (1) a salt–root effect and (2) a serum–root effect. A third effect is also shown in Fig. 1, but it is more distinct if the values of the 'serum–water' curve in Fig. 1 are converted into percentages of the values of the 'water' curve in Fig. 1, while the values of the 'serum–salt' curve in Fig. 1 are converted into percentages of the values of the 'salt' curve in Fig. 1. As percentages, the values of the 'serum–salt' curve fall below those of the 'serum–water' curve.

Is this third effect due to a salt–root action, so that the sensitivity of the roots to serum action has been changed in the saline dilution, or is it due to a salt–serum action?

The answer must be sought in Fig. 2, which shows the results of six growth experiments, in which an ultra-filtrate (*UF*) of a heat-denatured 33 per cent serum–water solution has been used as

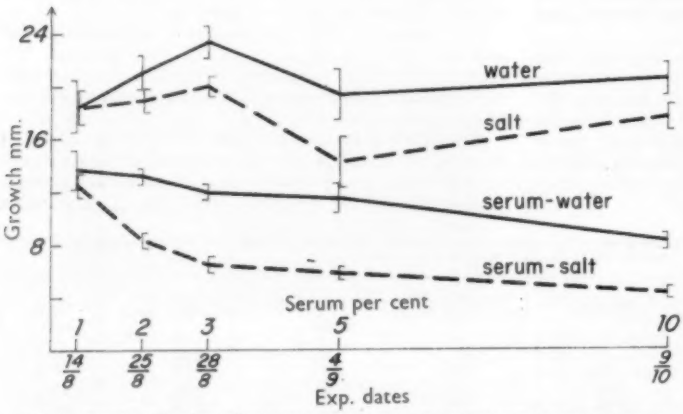

Fig. 1. Growth of *Lupinus albus* roots in water and salt solutions with or without serum added, in five independent experiments. Ordinates: growth in mm. in 24 hr. at 15° C.; abscissæ: (1) dates of experiments (1958), (2) percentage (v/v) of serum in water or salt solution in the two lower curves. Serum from one proband, freshly taken on each experimental date. Vertical transverse lines on curves: 95 per cent fiducial limits

nutrient medium, diluted partly with water and partly with the triple-salt solution already mentioned. The concentrations of the ultra-filtrate in the solutions are plotted as abscissæ, the solutions having been diluted so that the percentages refer to the original serum concentration before heat-denaturation and ultra-filtration. By heat-denaturation all bound phytohormones will be released from the serum proteins[4].

Like the curves in Fig. 1, those in Fig. 2 also show three effects. Two of these, namely, (1) a salt–root effect and (2) a ultra-filtrate–root effect, correspond to the salt–root effect and serum–root effect already mentioned. The third effect shown in Fig. 2 is that the increment in the ultra-filtrate–salt solution constitutes a higher percentage of the increment in the salt solution without ultra-filtrate, as compared with the percentage which the increment in ultra-filtrate + water constitutes of the increment in water without the ultra-filtrate. This third effect in Fig. 2, where an ultra-filtrate of denatured serum is used as a specific nutrient medium, is thus directly contrary to the corresponding effect in Fig. 1, where native serum is used as a specific nutrient medium.

The *p*H of the solutions cannot be the cause of the difference recorded in the activity of native serum on one hand and an ultra-filtrate of denatured serum on the other, since all solutions containing Shive salt have a lower *p*H value than the corresponding solutions in which distilled water is used as diluting agent. In Fig. 1 the most acid serum–salt solution has thus the greatest root-growth inhibition, whereas in Fig. 2 the most acid ultra-filtrate–salt solution has the smallest root-growth inhibition.

An ultra-filtrate of denatured serum contains all its phytohormones in the free, unbound form, whereas native serum contains most of its phytohormones in the bound form[4]. Since a nutrient solution in which all phytohormones are found in the free form (the curves with ultra-filtrate in Fig. 2) has thus shown an effect contrary to that of a nutrient solution in which the same phytohormones are present in partially bound form (the curves with serum in Fig. 1) but where otherwise all other factors are alike, the difference must be due to the serum protein component in Fig. 1. In an experimental arrangement analogous to that of the experiments in Figs. 1 and 2, four experiments with varying concentrations of urine, which, in some respects, may be regarded as an ultra-filtrate of serum, have shown the same effect as found in the experiments with an ultra-filtrate of denatured serum. This also suggests that the difference between the results shown in Figs. 1 and 2 is due to the protein component in the nutrient solutions in Fig. 1.

That native serum diluted with a salt solution has thus shown the greatest inhibition of root growth, relatively as well as absolutely, compared with its effect when diluted with water, must therefore be interpreted as being due to a protein–salt effect rather than to a salt–root effect.

Since phytohormones can only be imagined to affect roots when present in the free form, the increased phytohormonal effect in serum diluted with a salt solution must be due to the fact that the salts release quantities of phytohormones from the native serum proteins.

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2,6-Dichlorobenzonitrile: a New Herbicide

IN the course of a screening programme investigating the herbicidal activity of various benzonitriles and related compounds it was found that many of these substances inhibited the growth of young oat plants and the germination of seeds of many weed species.

The most active compound in this series proved to be 2,6-dichlorobenzonitrile (code No. *H* 133). The germination of seeds is especially inhibited by very small amounts of *H* 133. This inhibition is illustrated in Fig. 1, where millet seeds (*Panicum miliaceum*) have been sown on a 2 per cent agar containing the indicated amounts of 2,6-dichlorobenzonitrile per ml. The tubes contained 10 ml. of the agar solution. A concentration of 5×10^{-5} mgm. of *H* 133 per ml. strongly inhibited germination. In a comparison with *iso*propyl-N-phenylcarbamate (I.P.C.), the same degree of inhibition occurred at a dose of about 5×10^{-3} mgm.

H 133 is easily absorbed by seeds either from a solution or from the vapour. In laboratory experiments the germination of wild oats was completely inhibited if flats were sprayed with amounts of *H* 133 corresponding to doses of 0·5–4 kgm. per hectare depending on the type of soil. Seeds of some plant species, for example, rice, groundnuts, maize and sunflower, showed a distinct resistance to *H* 133.

Besides inhibition of germination the effects of *H* 133 appear in general killing or stunting the growth of young plants. Older and also full-grown plants were not damaged by this compound. After application of small amounts of *H* 133 various effects on plants could be observed. Growing tips are obviously very sensitive to this compound. *H* 133 thus acts via the roots as well as by way of the green parts of the plants.

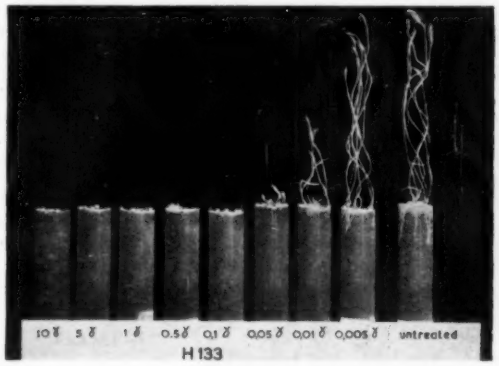

Fig. 1

Fig. 2

When applied in a lanolin paste to the stem of bean plants a local swelling of the stems occurred, mainly caused by an increase in diameter of the parenchyma cells. The stems of sunflower and groundnut plants also showed a characteristic swelling. In plants like tobacco and *Salvia*, leaf growth is inhibited simultaneously with an increase in thickness of the leaf.

H 133 is very active in vapour form, in spite of the low vapour pressure (3×10^{-6} mm. mercury at 20° C.). A characteristic effect is illustrated in Fig. 2, where young oat plants were exposed to the vapour of *H* 133 during 24 hr. by covering them with glass bells containing in the top a piece of filter-paper with a certain amount (0·01–0·07 mgm.) of *H* 133. The young leaves toppled over and all cells in the actively growing meristems collapsed (Fig. 2).

The same effect may be observed under appropriate conditions 10 min. after spraying the plants.

Sprouting of stored potato tubers is completely inhibited by exposure to *H* 133 vapour.

In an *Avena* coleoptile section test an antiauxin effect was observed. Concentrations of 10^{-4} mgm. of *H* 133 per 0·5 ml. buffer inhibited the growth stimulation of 10^{-3} mgm. of indole acetic acid per 0·5 ml. buffer solution.

Experiments in which respiration or photosynthesis was measured in a Warburg apparatus showed that neither respiration nor photosynthesis of tobacco leaves was inhibited, if the leaves were placed in a saturated solution. The solubility of *H* 133 in water is 18 p.p.m.

A specific effect of *H* 133, for example, the toppling over of young oat plants, was not observed, if known herbicides, as phenoxyacetic, phenylacetic or benzoic acids, were used. On the other hand, leaf modifications as caused by phenoxyacetic and benzoic acids have never been shown.

The acute toxicity of *H* 133 for warm-blooded animals is low. The acute oral *LD*50 for mice is >6 gm./kgm. body-weight; the acute intraperitoneal *LD*50 for mice is >3 gm./kgm. body-weight.

These effects of *H* 133 indicate its possibilities as a herbicide. It is active against many weeds, for example, wild oat (*Avena fatua*), bracken (*Pteridium aquilinum*), chickweed (*Stellaria media*) and cleavers (*Galium aparine*), whereas some crops have proved resistant to it.

A full account of these investigations will be published elsewhere.

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Volvox Colonies and Snail 'Cytase'

Having seen the very striking way in which snail 'cytase' brings about the dissolution of cell walls in angiosperm roots (following the suggestion for its use in cytological techniques[1]), I wondered what effect this substance might have on a colonial organism such as *Volvox*. Would it be possible to separate the cells of the colony into a swarm of *Chlamydomonas*-like creatures, or, better still, would it be possible to liberate the protoplasts as free-swimming naked individuals?

Small quantities of a culture of *Volvox aureus* Ehr. were placed in watch glasses and sufficient of the coffee-coloured 'enzyme' (obtained from the crop of the edible snail) was added to each to bring the strength of the enzyme up to about 20–25 per cent of the total bulk of the liquid.

The treated colonies were kept at room temperature and examined under the microscope from time to time for up to three days. At no time did any of them show any signs of separating into individual free cells. The only visible effects of the treatment were (*a*) the production of one or more large dimples in most of the colonies, presumably due to slight plasmolysis, and (*b*) a slight swelling of the outer region of each colony.

The ability of the colonies to resist dissolution was quite unexpected, especially since the 'enzyme' is known to contain at least twenty constituents capable of acting on a wide range of carbohydrates. As a check on the activity of the snail enzyme under the conditions and at the dilution described above, a little ground wheat endosperm was added to some of the watch glasses after 12–24 hr., and in each case both the starch grains and the cellulose endosperm walls were readily dissolved.

Thus although it is possible to obtain a positive cellulose reaction on *Volvox* by treatment with iodine and sulphuric acid, it seems that in the living condition the material forming the matrix of a colony must either be very different from that of the walls of higher plants, or it must be protected in some way by the incorporation of some substance (such as protein) which is not attacked by the snail enzyme.

I wish to thank Miss E. H. Evans for supplying the snail enzyme and the Cambridge Culture Collection for the culture of *Volvox aureus*.

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RADIOBIOLOGY

Significance of Adrenals for Increased Oxygen Consumption in Rats during Irradiation

The first minute of exposure to ionizing radiation produces in animals many changes which may be explained as stress reaction. In my previous communication I had shown a significant increase in oxygen consumption in rats during irradiation with a dose-rate of 50 r./min.[1]. Since I believe that this increased oxygen consumption is a demonstration

of stress reaction too, I should like to explain the role of adrenals in these changes in the following experiment.

I used 60 female rats (Wistar strain), average weight 200 gm. Bilateral adrenalectomy was performed on 50 rats, sham operation on 10 rats. The adrenalectomized rats were fed on a standard Larsen diet and drinking water was replaced by saline solution. The division in groups was as follows: (1) experimental group: (adrenalectomized, irradiated rats) (40 rats); (2) control group: (adrenalectomized rats without irradiation) (10 rats); (3) control group: (sham operated, irradiated rats) (10 rats).

The methods of measuring and irradiation was described in my previous communication[1].

The course of oxygen consumption in experimental and control rats is given in Fig. 1. In all irradiated groups, the oxygen consumption was already significantly increased in the first minute of irradiation with a dose-rate of 50 r./min. The difference in oxygen consumption between group 1 and group 2 is statistically significant ($P < 0{\cdot}01$). The oxygen consumption in rats after sham operation has increased much more ($P < 0{\cdot}005$) than in the experimental groups.

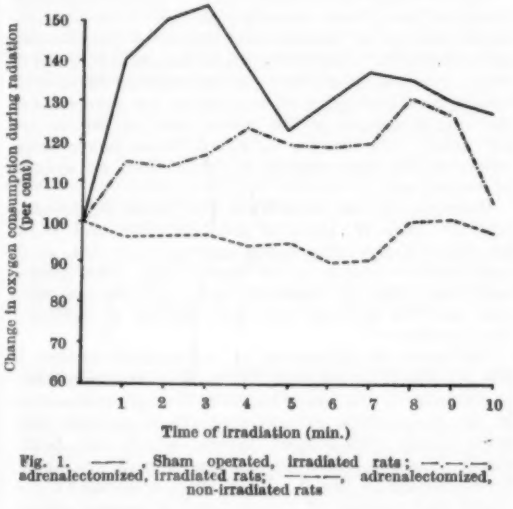

Fig. 1. ——, Sham operated, irradiated rats; —·—·—, adrenalectomized, irradiated rats; – – – –, adrenalectomized, non-irradiated rats

As oxygen consumption was increased during irradiation in all adrenalectomized rats I believe that an increase in oxygen consumption could not be explained as the influence of accidental accessory suprarenals. In accordance with Selye's experiments, I do not exclude the possibility that the changes in oxygen consumption during irradiation are a manifestation of radiation stress[2].

The difference in the increased oxygen consumption during irradiation, both in experimental and control irradiated rats, indicated that the change in oxygen consumption is higher in presence of the adrenals. I assume that adrenals, too, take part in the increasing oxygen consumption. But the velocity of the increase in oxygen consumption in the first minute of irradiation rather indicates a presumably reflex mechanism of these changes. I suggest that the increase in oxygen consumption has been produced, on one hand, by a direct influence of the nervous system on tissue metabolism, and, on the other hand, these changes are later accompanied by humoral factors.

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Hazard of Tritium as a Deoxyribonucleic Acid Label in Man

In the Recommendations of the International Commission on Radiological Protection[1,2] (1955, 1960) on maximum permissible body burden, tritium is considered only in water which is widely and uniformly distributed throughout the body. It is pointed out in the Recommendations that great care must be taken in applying these data to other chemical forms which may give a different localization. However, this fact is still not always appreciated and although it is particularly serious for tritium. The average range of its beta-particles is only about 1μ (maximum range about 7μ) and the local dose-rate will have reached about half the maximum for a deposit of isotope in a volume of the order of only $10\mu^3$. Further, an increased relative biological effectiveness is to be expected for these low-energy beta-particles compared with gamma radiation, and from observations of radiation effects on cell growth, Pinson and Langham[3] have suggested that a value of 1·7 should be used.

One of the frequent applications of tritium is in labelling precursors of deoxyribonucleic acid such as thymidine. These will be taken up specifically by the limited number of cells in the period of synthesis of deoxyribonucleic acid prior to division. The radioactive material will then be associated with the chromosomes and will produce local irradiation of an essential part of the cell, being particularly likely to interfere with division or to produce gene mutations. A concentration of only 0·03 μc./gm. within a nucleus of $500\mu^3$ could deliver a dose of 0·06 rad (0·1 rem) in one week within that nucleus, and such an uptake in some 10^{12} dividing cells would constitute a body burden of 15 μc. (ref. 4) only 1/167 of the latest International Commission on Radiological Protection value[2].

We have directed attention to the possibility of appreciable radiation effects from the amounts of tritium-labelled thymidine used in autoradiography[4,5]. In fact, marked toxic effects have been observed in tissue culture by Osgood[6], and by Painter and Drew[7], who reported that 0·1 μc./ml. medium for 24 hr. or 0·02 μc./ml. medium for 72 hr. resulted in the death of 90 and 50 per cent of cells respectively.

Painter, Drew and Hughes[8] compared the effects of tritium-labelled water and tritium-labelled thymidine in the medium for 24 hr., on the inhibition of growth of Hela cells. Comparable depressions were produced by 5,000 μc./ml. medium and 5 μc./ml. respectively. Allowing for a relative biological effectiveness of 1·7 this implied a 'concentration' factor of 590/1. This is a greater difference than suggested above in connexion with body burden; but it must be realized that in this latter case the dose of 0·1 rem was averaged over the total nuclei

incorporating the material. However, the range of the particles is so short that the radiation effect is limited to small volumes even within these nuclei. A particle of the average energy (0·055 MeV.) can be considered to dissipate this energy within a sphere of only 1μ diameter, corresponding to a dose within this small volume of some 168 rads (286 rems if a relative biological effectiveness of 1·7 in fact applies), so that a single particle is capable of producing very marked radiation effects within its limited range. This represents 5–10 times more energy than would be left in a similar volume, adjacent to the point of emission, by the first part of the track even for a beta-particle from carbon-14, and the difference is even greater for particles of higher energy.

Johnson and Cronkite[9] have found comparable radiation effects on mouse spermatogonia *in vivo* at 60 hr. after an injection of tritium-labelled thymidine 1 μc./gm. of body-weight, or a single dose of 5 r. of gamma radiation. This amount of tritium is about that needed to produce a good autoradiograph of cellular uptake, which requires some 6×10^4 atoms per nucleus of $500\mu^3$ volume corresponding to some 6 μc./gm. of nucleus[4]. Thus, a concentration factor of the order of 10 applies in this case between the concentration of thymidine in nuclei and in whole body; but, of course, the uptake in any particular type of cell will depend on the local pool of thymidine, which will vary from tissue to tissue[10]. An average concentration of 6 μc./gm. will give a dose of 4 rads (or 6·8 rems) per 60 hr., which is, in fact, similar to the observed equivalent gamma radiation dose.

There would be a difference between the cells initially receiving damage in these two cases. Gamma radiation would damage a certain proportion of all cells at random, although this damage might not become obvious until the cells attempted division at some later time. Following a single injection, thymidine would be taken up specifically by cells already preparing for division and only these cells would initially show damage. However, the nature of the tritium localization in chromosomes of dividing cells would favour production of mutations (with consequent risk of carcinogenesis, leukæmia, etc.). Further, although there are at present no data on the biological half-life of deoxyribonucleic acid pyrimidines *in vivo*, it is known that deoxyribonucleic acid purines from damaged cells are re-utilized efficiently for synthesis of deoxyribonucleic acid[5]. In the event of tritiated thymidine being given continuously, all dividing cells would in the end receive radioactive material, and, if there is appreciable re-utilization of material, the maximum cell content could gradually increase.

Thus, the particular nature of uptake and the lack of knowledge on local pools and re-utilization make it very difficult to lay down any maximum permissible body burden for tritiated thymidine. It is certain that appreciable organ radiation effects may be observed after even the low doses necessary for autoradiography. However, in general, with tritiated deoxyribonucleic acid precursors the main concern is not with organ damage (as only the proportion of cells in synthesis of deoxyribonucleic acid at the time of administration will be affected), but rather with mutagenic effects in those cells which have a long life span and several mitotic cycles in the body (for example, bone marrow stem cells and any 'stem' population). In these cells it is meaningless to consider rads per nucleus, as the uneven distribution of energy within the nucleus may or may not affect a vulnerable volume by chance.

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BIOLOGY

Age Determination in the Harbour Seal, *Phoca vitulina* L.

Recent detailed investigations of the life-histories of several arctic and antarctic phocids[1–3] have established the use of incremental layers in the dentine and cementum of canine teeth as accurate indicators of age. Such studies have relied on seasonal differences in the rate and type of deposition for determining the annual nature of the layers, but so far as we are aware, the results obtained have never been validated by examination of teeth from an animal of known age.

Recently, we acquired from Dr. Victor B. Scheffer and Mr. Dale W. Rice, of the U.S. Fish and Wildlife Service, the right upper canine of an old adult male harbour seal from the Seattle Zoo. This animal had been kept in captivity since its capture as a pup, and its age was therefore known to within a few months.

The tooth is illustrated in longitudinal section in Fig. 1, which shows that the bulk of the cementum is confined to the lower half. A thin-ground section in the same plane reveals that the cementum contains many well-defined layers, which are better resolved in the transverse section (Fig. 2) cut at the level marked in Fig. 1. Each layer is about 125μ in width and consists of a wide band of opaque cementum and a narrow translucent band. Examination

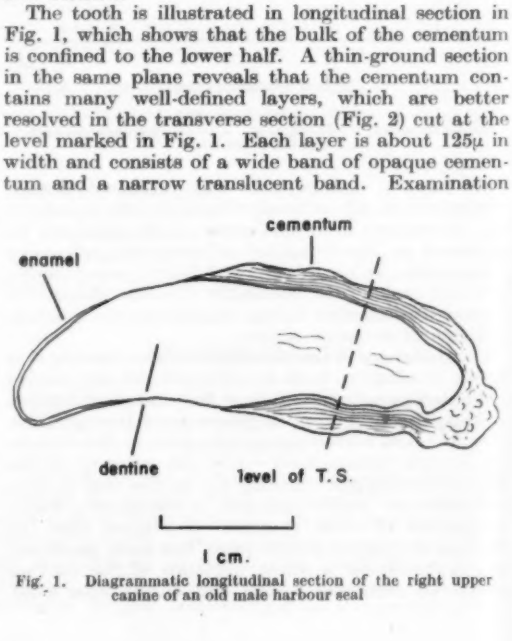

Fig. 1. Diagrammatic longitudinal section of the right upper canine of an old male harbour seal

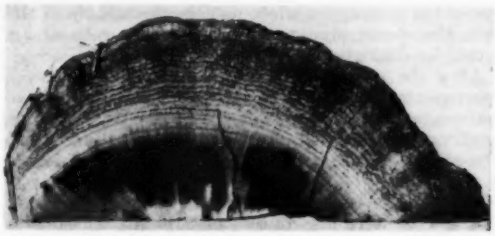

Fig. 2. Half of a transverse section of the same tooth cut at the level shown in the diagram. At least eighteen layers can be counted in the cementum

of other specimens shows that the translucent band is laid down in the spring and early summer and may represent a period of minimal feeding during the breeding period and the moult, as is found in some other phocids[1,2].

Preliminary counts gave the number of cementum layers as 18–20, the lower figure being finally chosen since it was the most certain. After our examination had been made, we learned from Dr. Scheffer that the seal was 19½ years old, a fact which confirmed the annual nature of the cementum layers. There were no clearly marked dentinal layers in this particular tooth, but examination of other canines from both male and female harbour seals has shown that, where dentinal layers are present, they agree in number with those in the cementum.

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Anomalies in the Microscopic Structure of Some Wools

The bilateral division of the cortex of merino wool into ortho and para sections has been clearly shown by many workers[1,2], and can easily be demonstrated by dyeing the fibres with methylene blue at the boil, at *p*H 7·4. When this experiment is carried out with Southdown or Corriedale fibres the shape of the two portions is often anomalous. Near the division between stained (ortho) and unstained (para) portions there often appears a core, often within the para-cortex, but stained more deeply than the ortho. When the experiment is repeated at *p*H 6 (at which very little segmentation is discernible in Merino) this core remains deeply stained and clearly distinguishable from the ortho-cortex, which is relatively pale (Fig. 1). It is concluded from this experiment, and other similar experiments with fine crossbred wools, that in some types of wool a core more basophilic than the ortho-cortex exists, usually at the junction between the ortho and the para portions, and sometimes completely in the para-cortex. In a sample of Southdown fibres one-third had such a core, and in Corriedale about two-thirds. When whole fibres are examined this core is towards the inside of the curve of the crimped fibre. It is proposed to call this core the meta-cortex.

The position and basophilic nature of this meta-cortex suggest that it might be related to the medulla, but, of course, no medulla is found in these fine crossbred wools. However, when a sample of white alpaca fibres was likewise stained at *p*H 6, it was possible to pick out fibres with a broken medulla joined by deeply stained cores. When slides of these fibres, viewed in the microscope, were flooded with acetic acid the blue stains of the core disappeared leaving the medulla portions still visible. Occasionally, fibres stained at *p*H 6 showed a length of core with a few vacuoles along one edge (Fig. 2) and sometimes a concentration of vacuoles at one end. A sample of Masham wool similarly treated showed a mixture of core and medulla similar to that found in alpaca. One fibre showed some portions with two medullæ (as is often found in llama) of which one was continuous throughout, and the other, which was thin, was replaced in portions by a single line of deep blue spindle-shaped cells, sometimes in line and sometimes overlapping. This again suggests a relation between the medulla and the core or meta-cortex.

It would also seem that the three regions of the cortex are different in sulphur content. Thorsen[3] has published pictures of Rambouillet, Suffolk and Navajo wool fibre cross-sections, stained in sodium plumbite, in which there is an unstained core as well

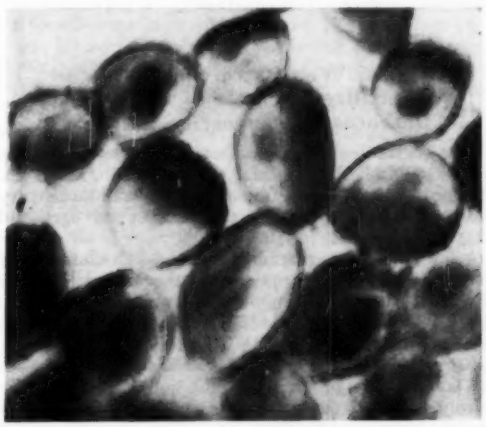

Fig. 1. Southdown wool stained with methylene blue at *p*H 6

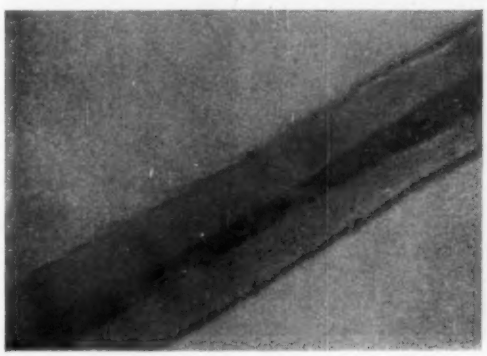

Fig. 2. White Alpaca stained with methylene blue at *p*H 6

as two regions corresponding to the ortho- and para-cortex. When Southdown and Corriedale fibres are similarly stained in sodium plumbite, some of them exhibit an unstained, sulphur-deficient, core near the junction of the dark brown para- and the light brown ortho-, often within the para-cortex. The fraction of such fibres is similar to the fraction of those showing a meta-cortex when stained with methylene blue at *p*H 6. A similar phenomenon can be seen in white alpaca stained with sodium plumbite. The medullated fibres (the majority) show a white, sulphur-deficient, ring around the medulla, often within the para-cortex, and unmedullated fibres simply show the white core in the same position. The apparent sulphur deficiency of the meta-cortex and the known sulphur deficiency of the medulla[4] are thus consistent with the association between meta-cortex and medulla noted earlier.

These observations would indicate that the medulla and the meta-cortex may be similarly derived within the fibre follicle.

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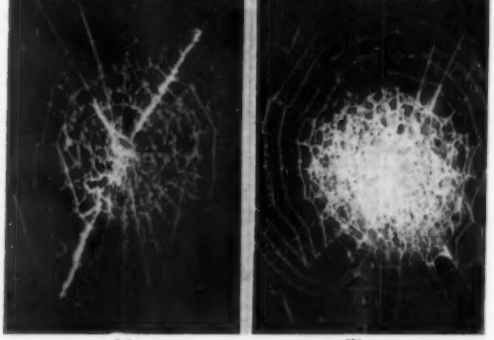
Unusual Web Pattern made by an Unfertilized Female of the Spider *Uloborus walckenaerius* Latreille

A mature female of *Uloborus walckenaerius* was found in May 1959 in the precincts of Jerusalem. The female lived about four months in the laboratory and reached a large size; she did not lay eggs and was probably not fertilized.

A few weeks after bringing her into the laboratory an unusual pattern appeared in her web. Besides the usual radial stabilimentum, an additional design appeared, forming a lace-like delicate pattern in the centre (Fig. 1*a*). During the following days the pattern became denser and its area larger. Towards the end of this process the additional threads completely covered the normal stabilimentum and the whole central area (Fig. 1*b*). The new formation resembled a compact white spot in the middle of the web, the dense area reaching in some webs about 5 cm. in diameter.



(*a*) (*b*)

Fig. 1. Central part of the web of *U. walckenaerius* with additional pattern. *a*, Initial stage; *b*, final stage

After the web was destroyed the spinning process was repeated. The unusual additional stabilimentum pattern appeared in large normal webs as well as in small ones, which resembled primitive cocoon webs. The rate of spinning activities of this unusual pattern is variable.

At the same time some females of another species of *Uloborus* were also found, in outward appearance and size very similar to *U. walckenaerius* but distinctly differing in colour. Unfortunately the species has not so far been determined. One of these females, probably also unfertilized, spun similar additional stabilimentum patterns in her webs. In addition, during July this female spun an unusually large but empty cocoon, resembling in form a typical cocoon of *U. walckenaerius*, and placed it on a cocoon web beside her web. On the fourth day the empty cocoon was torn off (probably by the spider itself) and found lying beneath the web. The spinning of an empty cocoon confirms the supposition that the female was not fertilized.

Both phenomena, the unusual web pattern and the spinning of the empty cocoon, in an unfertilized female show that: (1) increased silk production in the mature female is probably independent of fertilization, and leads to an unusual stabilimentum pattern in the web; (2) making the cocoon may be independent of egg-laying.

Although it is difficult to judge by a single observation of throwing away an empty cocoon, it nevertheless suggests the existence of some action to control the completed cocoon. This latter suggestion needs further investigation.

I am grateful to Dr. A. Shulov for identifying *U. walckenaerius*.

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Perfect Stage of *Microsporum gypseum*

In 1927, Nannizzi[1] reported the discovery of the perfect stage of *Microsporum gypseum* (Bodin) Guiart and Grigoraki and named it *Gymnoascus gypseum* Nannizzi. This work was criticized on a number of grounds, and, as there has been no record of its successful repetition, it has been generally disregarded.

I, by chance, rediscovered this same perfect stage in April 1959 when I noticed the presence of cleistothecia typical of the Gymnoascaceae associated with *Microsporum gypseum* growing on hair resting on the surface of moist soil in a laboratory experiment. This conclusion is supported by the following evidence: (*a*) macro-conidia of *M. gypseum* were borne directly on the characteristic peridial hyphæ of the cleïstothecia; (*b*) both ascospores and macro-conidia gave rise to colonies producing both the sexual and asexual stage, although the sexual stage was only produced if the fungus was grown on hair mixed with moist soil, in the confirmatory tests the whole system having been sterilized prior to inoculation. Although the cleistothecial characteristics of the present isolate differ in certain respects from Nannizzi's diagnosis of his isolate, the differences are explicable and I regard the two to be conspecific.

The species is only doubtfully a member of the genus *Gymnoascus*, but no change in generic position is proposed as yet. Full details will be published elsewhere.

Considered with the recent discovery of the perfect stage of the closely allied *Keratinomyces ajelloi*[2], the case for the gymnoascomycete derivation of this important group of dermatophytes is strengthened.

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Dec. 2.

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Occurrence of the Slipper Limpet, *Crepidula fornicata* L., in Ireland

In May 1959, during an investigation of the intertidal ecology of the Kenmare River, Co. Kerry, full-grown single individuals of this American gastropod were found to be common below mid-tide level at Kilmakilloge Harbour, a shallow and protected inlet on the southern shore of the estuary. This species is well known as a pest of oyster beds on the eastern and southern shores of England, and is also present in Wales[1], but is believed not to have been recorded previously from Irish waters. Studies on the biology of *Crepidula* have shown that distribution on ships is the main, if not the only, means of remote dispersal[2]. It is therefore probable that this species has reached Ireland attached to vessels previously laid up in British harbours. As part of the survey, a special search was also made for the Australasian barnacle *Elminius modestus* Darwin which, though now widespread in Britain[3], has in Ireland only been reported from Lough Ine, Co. Cork[4]. However, *Elminius* was not found anywhere within the Kenmare River, nor was *Crepidula* noted at other localities.

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A Mesozoic Microflora from South Africa

In 1948 I examined a specimen of low-grade coal from the Gamtoos River, Eastern Cape Province, South Africa, and found it to be particularly rich in microspores. Carbonaceous mudstones and shales in the Wood Beds of the Uitenhage series in the Gamtoos River basin were afterwards found to contain a comparable, though much less rich, spore assemblage, thus giving a fairly consistent picture of a Mesozoic flora of the region.

At the time of investigation it did not seem possible to name many of the sporomorphs; but owing to the progress in sporomorph taxonomy of the past ten years many can now be named, at least tentatively. Of particular interest are three species of saccate sporomorphs. One of these is similar to, if not identical with, *Pityosporites ellipticus* (Cookson) Balme, a form known from Australia and New Zealand[1]. Another is *Podosporites* c.f. *microperus* (Cookson and Pike) Balme, this genus being known from India and Australia. Both sporomorphs have been regarded as likely Podocarpaceae. The third is *Caytonipollenites pallidus* (Reissinger) Couper, identical in form with pollen of *Caytonanthus* (Caytoniales) and very likely referable to this widespread group of Mesozoic Pteridospermae[2].

Other sporomorphs include *Classopollis torosus* (Reissinger) Couper, *Tsugaepollenites* sp., *Ginkgocycadophytus* sp., *Cicatricosisporites* c.f. *brevilaesuratus* Couper, and trilete spores resembling those of Cyatheaceae, Dicksoniaceae, Matoniaceae, Schizaeaceae and Gleicheniaceae. A total of about thirty sporomorph species has so far been distinguished.

The age of the Uitenhage Wood Beds is regarded as Wealden[3]. The spore assemblage, so far as it has been studied at present, is quite consistent with this, though not proving it, as the microflora is typically mid-Mesozoic, closely comparable with Upper Jurassic and Lower Cretaceous ones and apparently lacking certain forms which seem to be typical of the Lower Cretaceous of Australia, such as *Cicatricosisporites australiensis* (Cookson) Balme and *Microcachrydites antarcticus* Cookson.

Mid-Mesozoic microfloras of South Africa have not been investigated, and the present study suggests some resemblances to both northern and southern floras of about the same age, that is to say, a southern and a cosmopolitan element are present. In view of the occasionally mooted theory of southern origin of angiosperms in lower or mid-Mesozoic times, it is perhaps worth stressing that the present limited evidence is only negative. A fuller taxonomic account of the material is in preparation.

I am indebted to Dr. J. Hewitt, formerly director of the Albany Museum, Grahamstown, for material; to the Council for Scientific and Industrial Research, South Africa, for a grant for palynological studies; and to the Commonwealth Scientific and Industrial Research Organization, Coal Research Section, New South Wales, for assistance in nomenclature.

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Cell Wall Formation in Spores of the Fungus *Allomyces*

In attempts to elucidate the details of plant cell wall formation, it is obvious that certain types of cells may be more useful than others. The investigation of cells which begin their existence devoid of a wall but which acquire one later may possibly show structural features uncomplicated by the cumulative effects of growth and differentiation. It has been shown by Nicolai[1], who investigated cell wall formation in the green alga, *Chaetomorpha*, that spores of lower plants can fulfil the special requirements for investigations of this kind. She observed that the motile reproductive cells of this alga were able to form a well-defined cell wall within 24 hr. after cessation of motility. Furthermore, changes in the form and crystallinity of the cell wall constituents

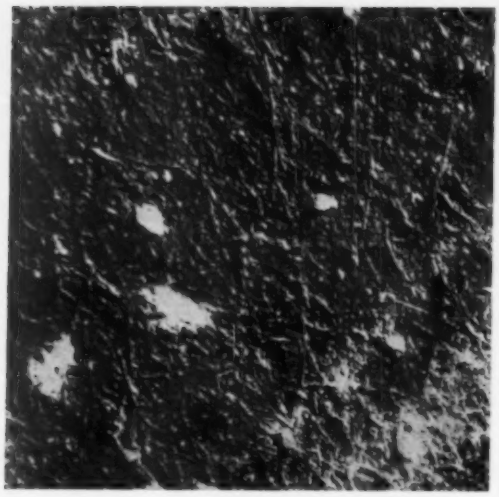

Fig. 1. Electron micrograph of a portion of the cell wall of a 24-hr. 'sporeling'. (Shadowed with platinum. × 36,000)

were detected by electron microscopy and X-ray analyses.

We thought it would be of interest to examine a similar situation in fungi. For this purpose, zoospores of *Allomyces* were used. These uniflagellate spores are considered to be without cell walls at the time of their formation and liberation from sporangia[1]. At this stage they are quite fragile and it has not been possible, thus far, to obtain preparations showing the structure of the surface of motile spores. Within 24 hr., however, observations in a light microscope show that a cell wall is present. We have made a preliminary electron microscopic study of the walls of these 24-hr. old 'sporelings'. They have been found to contain microfibrils in random arrangement, embedded in amorphous material (Fig. 1). By collecting a large number of zoospores and suspending them in a dilute nutrient medium for 24 hr., enough material was obtained for an X-ray analysis. Fig. 2 shows a comparison between X-ray powder diagrams of purified wall material from mature hyphae and partially purified material from 'sporelings'. Major reflexions attributable to chitin are present in both cases.

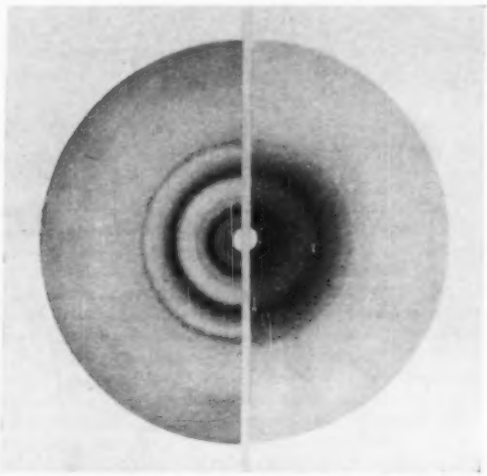

Fig. 2. X-ray powder diagrams of purified chitin from walls of mature hyphæ (left), and partially purified wall material from 'sporelings' (right)

Thus it is clear that, at a very early stage in development, the structural component of the cell wall of this fungus consists mainly of chitin microfibrils as has been found to be the case with the walls of mature hyphæ[2]. In so far as this investigation goes, it offers no evidence for an earlier suggestion that chitin is not the principal constituent of the walls during early stages of growth[4]. It seems, however, that the chitin is not as highly crystalline as that found later in mature hyphæ.

No attempt has been made to observe ontogenetic changes in wall structure from earlier stages or from the 24-hr. stage onward, and the precise time of formation of the first chitin microfibrils is unknown.

This work constitutes part of a programme supported, in part, by a postdoctoral research fellowship and supply grants awarded to one of us (J. M. A.) by the U.S. National Institutes of Health, Department of Health, Education and Welfare.

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ENTOMOLOGY

Mechanisms of Resistance of the Adult Housefly (*Musca domestica*) to 'Cyclodiene' Insecticides

Experiments have been conducted with isodrin and endrin labelled with carbon-14 in the terminal unchlorinated ring[1] and with aldrin and dieldrin labelled in the chlorinated ring (from the Radiochemical Centre, Amersham). Adult insects used were of a susceptible strain (S) and dieldrin-resistant strains (R_1) and (R_2). R_1 arose from the S-strain by exposure of the larvæ to dieldrin and R_2 from R_1 by removal of the dieldrin pressure after 19 generations[2].

Topically applied isodrin and endrin are less toxic than aldrin and dieldrin to S-flies[3], but the converse is true for the resistant strains described. Thus, in a 10 hr. observation (female flies without food or water), 20 μgm. aldrin topically applied in acetone did not affect R_1-flies but with isodrin the $KD50$ was about 3·0 μgm. R_2-flies were less resistant to aldrin and the $KD50$ for isodrin was about 1·0 μgm. It was of interest to compare the behaviour of these compounds in the three strains.

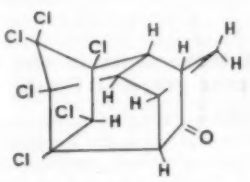
The radioactive insecticides were applied topically in 2 μl. acetone to the dorsal thorax of adult females in groups of 10–25 while under mild *cyclo*-propane anæsthesia and kept in fresh air at 25° without food

or water. The method of confinement and subsequent analytical techniques were those described previously[3].

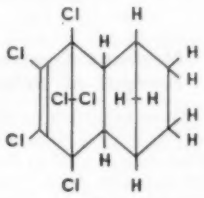
The results of experiments in which 2 μgm. of aldrin or isodrin were applied are given graphically in Fig. 1, which shows *internal* behaviour of the insecticides. *Total* recoveries were 75–85 per cent applied dose.

Penetration. A 2-μgm. dose of any of the insecticides produced severe signs of poisoning in *S*-flies in 1 hr., and at this time after application of aldrin the absorbed material (aldrin + dieldrin + acetone insoluble material in tissues) was similar for *S*- and R_2-strains, but greater in the R_1-strain. Subsequent penetration is similar in both *R*-strains but lower in *S*-flies (now knocked-down). Dieldrin penetrates into *S*- and R_2-flies at the same rate and faster than aldrin. Penetration is slower into R_1-flies, possibly due to the presence of inbred dieldrin in their tissues. The 2-μgm. dose of isodrin causes knock-down in the R_2-strain after 6–7 hr., but the penetration pattern is similar to that of aldrin; there was increased recovery of applied material in these experiments. Resistance does not appear to involve penetration differences and *R*-flies can survive with concentrations of absorbed insecticide in excess of those which would cause the death of *S*-flies.

Metabolism. All strains enzymically converted isodrin and aldrin to the corresponding epoxides endrin and dieldrin. Mixtures with the authentic epoxides could not be resolved by paper chromatography.



(I)



(II)

Acetone rinses from live insects following application of aldrin or isodrin also contained amounts of the corresponding epoxide which increased with time to about 8·0 per cent of the applied dose (50 per cent of the unabsorbed insecticide) after 8 hr. Epoxides were not formed either outside or inside heat-killed insects. This suggests that enzymic oxidation may also occur on or in the insect cuticle. Topically applied dieldrin was recovered from insects unchanged. Acetone extracts of live *S*- and *R*-insects treated with isodrin or endrin (this otherwise unchanged) contained similar small amounts of a water-insoluble product (Fig. 1*E*) which behaved as the ketone (I), a known rearrangement product of endrin[4], under the conditions of chromatography used. This ketone is virtually non-toxic when topically applied to *S*-flies. The conversion of aldrin and isodrin to their epoxides is shown in Fig. 1 (*C* and *D*).

The linear nature of these curves during the first 4 hr. when there are marked changes in the concentrations of aldrin or isodrin in the tissues suggests that oxidation is independent of precursor concentration. This might be due to rapid saturation of the oxidation site by the substrate.

The similarity between rates of production of dieldrin and endrin is interesting in view of the greater toxicity of the latter to the *R*-strains. Both

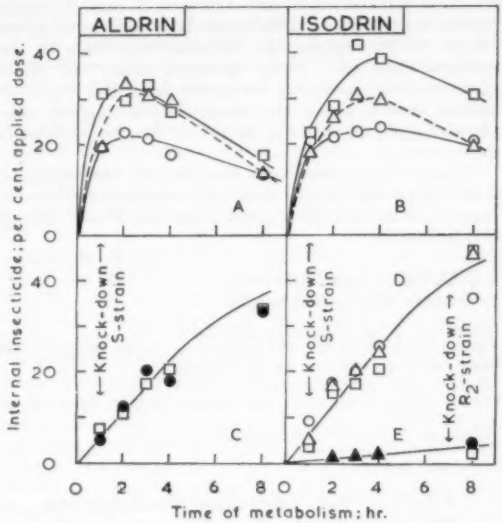


Fig. 1. Internal metabolism of ^{14}C-aldrin and ^{14}C-isodrin by adult ♀ houseflies exposed to a 2 μgm. dose. Curves: *A*, aldrin; *B*, isodrin; *C*, dieldrin production; *D*, endrin production; *E*, fast running fraction. ○—○, *S*-strain; △—△, R_2-strain; □—□, R_1-strain; ●—●, *S* and R_2; ▲—▲, all strains

aldrin and its oxidation product or isodrin and its oxidation product are present together in the tissues at the time of 'knock-down'. It is therefore difficult to decide whether either precursor or product or both are responsible for the toxic action. Perry *et al.*[5] noted the latent period between application of heptachlor to an *S*-strain and onset of symptoms which is not due to lack of penetration and cites this as an indication that death may be due to the action of the epoxide rather than to heptachlor. This is also true of aldrin. However, the reduction product (II) of aldrin, which cannot be oxidized, is still as toxic as chlordane[6], which suggests that the aldrin type of molecule has an intrinsic toxicity independent of metabolism possibilities. The results in Fig. 1 also show that resistance is not associated with a lower rate of oxidation *in vivo*.

Excretion. There was no reliable evidence in these experiments that radioactive material is excreted. Groups of insects with ani sealed[2], used as controls, lost as much radioactive material to the carrying papers as did the test groups, and analysis of this material revealed the same pattern. This loss by contamination may explain the appearance of epoxide in this fraction for both control and test groups after application of aldrin or isodrin, since epoxides were found on the insect cuticle.

Residual material in tissues. This fraction rose to 1–2 per cent of the applied dose (aldrin or dieldrin) for all strains at 8 hr. With isodrin and endrin there was an increase with time in all strains to the same level. This fraction was not extractable by water. The rather lower content in the R_1-strain which already contains inactive (carrier) dieldrin suggests that it may be unchanged insecticide intimately associated with the tissues.

These experiments suggest that resistance of *R*-flies to dieldrin is not due to lack of cuticular penetration, differences in metabolism, or excretion of the insecticide. Studies of the aldrin–dieldrin system and the isodrin–endrin system have not

revealed marked differences between *S*- and *R*-insects within a system, or differences between the systems which would explain the differing toxicities to the resistant strains. More detailed study of these systems may, however, be useful from the mode-of-action aspect, since the observations suggest that physiological factors are involved in the resistance mechanism.

These experiments are part of an investigation into the mechanism of dieldrin resistance in diptera, supported in part by a grant from the World Health Organization.

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Effect of Sub-Zero Temperatures on Diapause Eggs of *Acheta commodus* (Walk.)

It has come to be accepted that the optimum temperature for the removal of diapause varies from one insect species to another in a way that is related to the temperatures prevailing in the climatic zone inhabited by the species concerned. Thus, Danilyevsky[1] gives a series of instances in which the colder the climatic zone of the insect the lower is the optimum temperature for removal of diapause.

The range of temperatures effective in terminating diapause is quite wide and has been shown to extend below zero for a number of species. These species are all from cold climates and for most of them a long period of exposure to sub-zero temperatures is necessary. For insects generally, it can be said that, although the range of effective temperatures may extend below zero, the optimum temperature for the removal of diapause has been found to be between 0° and 15° C. It should be pointed out, however, that so far as species from temperate climates are concerned, very few experiments on the effect of sub-zero temperatures on diapause removal have been reported.

Previous work on the diapause of the common field cricket *Acheta commodus* indicated conformity with the above principles. *Acheta* is found in the temperate and sub-tropical regions in eastern Australia and has been quoted by Lees[2] as an example of an insect from a warmer environment that requires higher temperatures for the termination of diapause. Browning[3] has reported that the range of effective temperature extends from 8 to 27° C. with an optimum at about 13° C.

In these circumstances it is of interest to report that diapause in eggs of *Acheta* can be terminated by a short period of exposure to sub-zero temperatures. In these experiments diapause was induced by holding the eggs at 23° C. for 14 days. The period of exposure necessary to terminate it decreased progressively as the temperature was lowered.

At 12·8° C. the median duration of exposure was 20–60 days, depending on the strength of diapause in the eggs being tested. At −7·2° C. the mean value over a series of tests was 5 hr., while in one test at −16·5° C. a period of only 20 min. was required. At the latter temperature a proportion of the eggs was killed before the diapause reactions had been completed.

A further notable effect is that, at any one sub-zero temperature, a progressive decline in the percentage hatching occurs if the eggs are held beyond the optimum time for the elimination of diapause at that temperature. As the period of exposure was increased the proportion of eggs resuming development decreased to nil. When given the normal incubation, that is, 15 days at 26·7° C., such eggs showed no indication of development, and, when cleared by a method previously described[4], the embryos were found to be still in the diapause stage, but were abnormal in appearance. They remained in this condition even with prolonged incubation. It is presumed, therefore, that they were incapable of development and that the treatment had been lethal.

A more detailed description of this work will be published elsewhere.

I wish to acknowledge the capable assistance of Miss J. Kenyon in carrying out the experiments.

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Nervous Control of Movements in the Foregut of *Schistocerca gregaria* Forsk.

Observations on the nervous control of movement in the foregut of insects were first made by Marchal[1], who showed that in *Dytiscus marginalis* L. swallowing movements were abolished by the removal of the frontal ganglion. Yeager[2], in *Periplaneta fuliginosa* Serv., and Chauvin[3], in *P. americana* L., showed that the movements of the crop were independent of the intact nervous system. Further, Chauvin found that in *P. americana* L. the movements of the gizzard were dependent upon the presence of an intact nervous system; but in *Locusta migratoria* L. movements occurred in the whole isolated gut and were unaffected by agents such as acetylcholine and eserine. In general, movements of the gut are thought to be influenced by the ganglia of the visceral nervous system; but, with the exception of the work of Marchal, this does not appear to have been actually demonstrated in any insect. Arising from work still in progress upon the movements of the gut of *Schistocerca gregaria* Forsk., evidence presented in this communication was obtained of the visceral nervous control of some of the movements of the gut.

Preliminary investigations showed that a constant and repeatable pattern of gut movements could be obtained by starving the locusts for 160–170 hr. at 28° C. and 70 per cent relative humidity prior to the observation. All records refer to male adult locusts which had been pretreated in this manner. The whole gut, together with the brain, sub-œsophageal ganglion and intact visceral nervous system, was dissected out and placed in saline in a water-bath at 33° C. Several salines made to different

formulæ were tried, but only that of Griffiths[4] gave satisfactory results and was used throughout these experiments. To avoid the anæsthesia which results from immersing the whole insect in saline and to prevent the preparation drying out during the dissection, the hæmocœle was irrigated with saline immediately after the first incision had been made until the completion of these preliminary stages.

Records of gut movements were made by arranging the gut so that the posterior end was fixed and the anterior end fastened by a hook to a light balsa wood lever, tensioned by a weak spring and writing on a smoked drum. The gut was immersed in Griffiths–Ringer at 33° C. through which a slow stream of air was bubbling.

In each experiment, after normal contractions had been recorded for a minimum time of 20 min., the preparation was removed from the water-bath, placed under a binocular dissecting microscope and the appropriate operation performed. During this procedure care was taken to avoid changes in temperature. The operated specimen was then returned to the water-bath and its contraction recorded for a further period of at least 20 min. This process was repeated when further operations were performed upon the same specimen, in all cases care being taken to interfere with the preparation as little as possible.

The following operations were performed, results of which are shown in the accompanying figures.

(1) The brain and sub-œsophageal ganglion were removed by cutting through the circumœsophageal connectives and freeing these ganglia from the other tissues and the visceral nervous system. In all cases this operation was without effect upon the movements of the gut (Fig. 1*a*).

(2) The hypocerebral ganglion only was removed, by cutting through the inner and outer œsophageal nerves and the recurrent nerve. This changed the normal pattern of contraction and relaxation by appreciably slowing the relaxation which followed each major contraction (Fig. 1*b*). The smaller contractions and relaxations which come between the major ones do not appear to be affected by this operation.

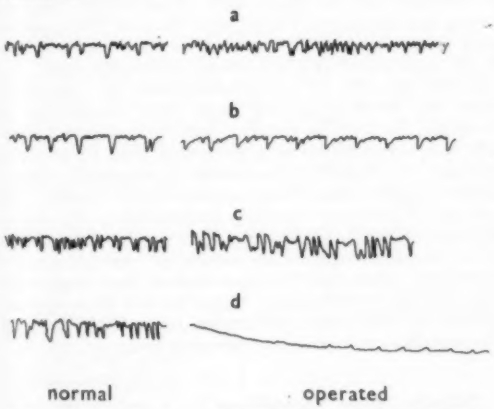

Fig. 1. Tracings of smoked drum records of gut movements of *Schistocerca gregaria*. The break in the tracing represents the moment at which the operation was performed. Time-scale shows minute intervals; the break represents a 5-min. interval. *a*, Removal of the brain and sub-œsophageal ganglion; *b*, removal of hypocerebral ganglion; *c*, severance of the outer œsophageal nerve; *d*, severance of the ventricular nerves

(3) The outer œsophageal nerves only were cut at a point approximately midway between the hypocerebral and ventricular ganglia. This operation had no effect upon the movements of the gut (Fig. 1*c*).

(4) The whole of the nervous system was intact and only the nerves arising from the ventricular ganglion and going to the gut were cut. This resulted in a complete cessation of the movements of the gut which lasted for some time, but eventually small infrequent movements appeared in the record (Fig. 1*d*).

As a result of these experiments the nervous control of gut movement may be interpreted as follows. The ventricular ganglion plays a major part in the control of gut movement and, in this respect, since movements continue normally when it is isolated from the rest of the visceral system, it is autonomous in its effects. The hypocerebral ganglion has an effect upon the movements of the gut: the negative results obtained after severing the outer œsophageal nerves show that this is not mediated through the ventricular ganglion. It presumably operates, therefore, either through the inner œsophageal nerves or through the recurrent nerve, and it influences the rate of relaxation of the gut musculature. The removal of the brain and subœsophageal ganglion was without effect upon the gut movements and therefore presumably plays no part in their control. This agrees with the observations of Chauvin[3] in *Locusta migratoria* L.

The certain identification of precisely which movements of the gut were producing which records on the smoked drum is still in progress. The movements observed here can almost certainly be attributed to the foregut, since visual observations show a correlation between these records and movements of the foregut. Further, the results of the above experiments on the visceral nervous system which innervates the foregut are in accordance with this view.

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Environmental Determination of Sex in a Parthenogenetic Parasite

In the Hymenoptera, the great majority of species reproduce by arrenotoky, fertilized eggs giving rise to females and unfertilized eggs to males, but some species reproduce by thelytokous parthenogenesis, the females arising from unfertilized eggs. In thelytokous species, it is not unusual for occasional males to occur.

Ooencyrtus submetallicus (Howard) (Encyrtidae), which is such a thelytokous species, is an egg-parasite of *Nezara viridula* (L.) (Pentatomidae). The males, which have no reproductive function, usually form less than 1 per cent of the adults. Individuals occur—normally very rarely—which are basically female but possess male areas of variable extent in the anterior portion of the body. It seems likely that these individuals are gynandromorphs, that is, that they comprise genetically male and female tissues. *O. submetallicus* reproduces within a temperature range

of 60–90° F. At temperatures above 85° many progeny die before reaching the adult stage.

Sex in *O. submetallicus* is dependent on temperature, and 85° is critical for sex determination. At 84° or lower, lines consist almost entirely of females; at 85°, lines cease in 2–5 generations with the sole production of males and gynandromorphs; and at 86° or higher, lines cease in the second generation similarly.

Sex is determined by the temperature to which the parent is subjected prior to deposition of the eggs concerned: it is not affected by the temperatures to which the deposited eggs are subjected. The period of parental life in which exposure to temperature determines sex of progeny includes the developmental period prior to emergence and the oviposition period after emergence. The sex of eggs deposited during the first few days of adult life is determined by the temperature to which the parent was exposed before emergence, and, as many eggs are deposited during these days, pre-emergence temperatures have an important effect on sex ratio.

The sex of the progeny laid after the first few days of adult life may be largely determined by the temperature experienced by the parent after emergence. There is a time-lag between an alteration in the temperature to which a parent is exposed and the consequent change in the sex of the progeny deposited. The rapidity of the change differs according to whether the alteration is from female-producing to male-producing temperatures, or vice versa. It appears that male-producing temperatures in the developmental period of the parent produce more profound or persistent effects on the sex of progeny than do female-producing temperatures.

The gynandromorphs arise when a parent is exposed, evidently at a critical stage of egg development, first to female-producing and then to male-producing temperatures. Variability in the degree of maleness is probably a function of the time in egg development at which this change takes place. Ability to reproduce is retained only by gynandromorphs showing slight signs of maleness.

Though males are normally rare, and gynandromorphs extremely rare, both can be produced in large numbers, or to the exclusion of females, by temperature manipulation.

The experimental data, which will be published elsewhere, appear to constitute the first proof of temperature determination of sex in any uniparental hymenopteran.

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Selection for High-Order Resistance to 'Dieldrin' in *Lucilia cuprina* Wied.

Homozygously DDT-resistant strains of *Musca domestica*[1] and 'Dieldrin'-resistant strains of *Anopheles gambiae*[2] have been developed in a single generation by the application of discriminating dosages which are lethal to susceptible and hybrid phenotypes in heterogeneously resistant strains of these insects. Selection experiments with chlordane on *Musca domestica* also imply that pure resistant lines follow one generation of selection with heterogeneous resistant strains[3].

Strains of *Lucilia cuprina*, free from both susceptible and hybrid phenotypes, may also be obtained with one generation of selection from partially resistant strains, providing the parent family lines contain a proportion, no matter how small, of males and females, which tolerate the high male and female discriminating dosages, established in the course of genetical experiments on the inheritance of resistance in this blowfly[4].

The selection procedure, employed during the past year, is as follows: Flies from heterogeneous strains are allowed to emerge from batches of pupæ on the first day into colony cages, after which the larger unhatched pupæ are isolated. Female flies mainly hatch from the segregated pupæ on the second day and are supplied with sugar, water and sliced liver.

When the male flies of the first day hatching are approximately 12 hr. old, the high male discriminating dose (2 μgm. of 'Dieldrin' per fly) is applied and surviving males at the conclusion of the holding period of 24 hr. are mated to the virgin female flies, which have hatched overnight. The female high discriminating dose (4 μgm. of 'Dieldrin' per fly) is applied to the female flies, 3–5 days from emergence. Male and female progeny from the selection tolerate their respective high discriminating doses, without mortality.

A further observation has been made in regard to this selection procedure with *Lucilia cuprina*. The progeny of parents, found by means of applying the high discriminating doses, tolerate significantly larger amounts of 'Dieldrin' than the parents. Is this merely vigour tolerance? For example, a strain in which considerable reversion towards susceptibility had occurred by the tenth generation contained no male or female flies able to tolerate 10 μgm. of 'Dieldrin' per fly. Five female and three male flies from this reverted strain survived their respective high discriminating doses. The male and female progeny from the parents not only tolerated the high discriminating dosages of 2 and 4 μgm. of 'Dieldrin' per fly, respectively, with complete survival, but, in addition, female flies were able to withstand 10 μgm. of 'Dieldrin' per fly, again with nil mortality. Inconsistent survival occurs with male flies at this dosage-level following a single generation selection, but 50–75 per cent survival often results with male flies.

A full account of both observations in connexion with the development of high-order resistance to 'Dieldrin' in *Lucilia cuprina* will be published elsewhere in conjunction with reversion data on selected strains. In regard to reversion of resistant strains, initial experiments have shown that during the process of reversion towards susceptibility the lower limit of tolerance to 'Dieldrin' of successive generations of a strain, developed by means of one-generation selection, progressively approaches the high discriminating dose-levels. Once hybrid flies appear, usually by the sixth generation, susceptible flies are diagnosable in subsequent generations.

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BACTERIOLOGY

Enhancement of Staphylococcal Virulence for Mice by Intraperitoneal Cortisone Acetate, Cholesterol and Lecithin

THE intraperitoneal administration of bile salts and of certain surfactants, followed by an ordinarily non-lethal inoculum of micro-organisms belonging to a number of different species, results in marked enhancement of the virulence of the latter for mice as manifested by a high incidence of fatal bacteræmia in these animals[1]. A similar capability of enhancement of virulence on the part of intraperitoneally administered cortisone acetate, cholesterol or lecithin with *Staphylococcus aureus* is reported in this communication.

Cortisone acetate suspension (Merck), 50 mgm./ml., as well as its vehicle, a saline solution containing suspending agents and 0·9 per cent benzyl alcohol, were obtained from commercial sources. Cholesterol (Fisher), 2·5 per cent, was prepared by suspending the amount indicated in distilled water, autoclaving at 15 lb. for 15 min., homogenizing in sterilized conditions in a Waring blendor to break up particles, after which the suspension, because of its settling tendency, was vigorously shaken immediately prior to each injection. Lecithin (Pfanstiehl), 2·5 per cent, was wet ground with a small amount of distilled water, brought to final volume with the same diluent and autoclaved. 5 per cent gastric mucin (Type 1701, Wilson) was prepared according to Miller[2]. *Staphylococcus aureus* strains were coagulase positive, hæmolytic and fermented mannitol. The above adjuvants were injected intraperitoneally in the amount indicated followed by 0·25 ml. of an 18-hr. culture of the staphylococci in trypticase soy broth at 37° C. into groups of 10 albino male Swiss mice weighing 15–20 gm. Deaths occurring within 48 hr. were noted. Post-mortem heart-blood cultures were streaked promptly upon expiration if death occurred during the day, and early morning if the animals died during the night, upon plates containing 1 part homogenized milk and 2 parts trypticase soy agar, which greatly favours pigment production by staphylococci, and positive results were tabulated.

The number of fatal bacteræmias produced within 48 hr. by the three test staphylococcal strains with 25 mgm. of each adjuvant under test and with 0·5 ml. of gastric mucin 5 per cent, for comparison, is noted in Table 1. Adjuvants by themselves all failed to evoke any mortality in preliminary toxicity tests. More than 90 per cent of the mice that died succumbed within 24 hr. As may be observed from Table 1, a high incidence of fatalities with septicæmia was achieved with the aid of each adjuvant under consideration whereas a similar intraperitoneal injection of staphylococci without their use proved innocuous. The effect of cortisone acetate suspension cannot be attributed to its suspending agent since the latter, alone, failed to elicit any mortality.

Table 1. MOUSE MORTALITY/10 AND POSITIVE POST-MORTEM HEART-BLOOD CULTURES ELICITED BY VARIOUS INTRAPERITONEAL ADJUVANTS WITH *Staphylococcus aureus* TEST STRAINS

Adjuvant	Dose (ml.)	*S. aureus* strain *A*	*S. aureus* strain *B*	*S. aureus* strain *C*
Physiological saline	0·5	0	1 (1)*	0
Gastric mucin, 5 per cent	0·5	10 (9)	10 (8)	8 (5)
Cortisone acetate suspending solution	0·5	0	0	0
Cortisone acetate, 50 mgm./ml.	0·5	10 (5)	10 (8)	9 (8)
Cholesterol, 2·5 per cent	1·0	9 (7)	9 (5)	9 (7)
Lecithin, 2·5 per cent	1·0	9 (6)	8 (7)	8 (5)

* No. of post-mortem heart-blood cultures positive for *Staphylococcus aureus*.

Table 2. DAILY MOUSE MORTALITY ELICITED WITH INTRAMUSCULAR CORTISONE ACETATE FOLLOWED BY *Staphylococcus aureus* STRAIN *A* OR PHYSIOLOGICAL SALINE, INTRAPERITONEALLY

Intramuscular cortisone acetate (mgm.)	Intraperitoneal injection (0·25 ml.)	Time of intraperitoneal injection	Mortality* Day 1 2 3 4 5 6 7 8 9
25	Physiological saline	Stat	0 0 0 1 3 0 0 1 0
25	*S. aureus* strain *A*	Stat	0 0 0 0 1 3 2 3 0
25	*S. aureus* strain *A*	24-hr post-intramuscular cortisone	0 0 0 0 1 3 0 3 0
5 — 3 × daily for 2 days	Physiological saline	Following final intramuscular cortisone	0 0 1 0 3 1 0 2 0
5 — 3 × daily for 2 days	*S. aureus* strain *A*	Following final intramuscular cortisone	0 0 2 0 2 3 0 1 0

* 10 mice in each group.

Cortisone is known to exert a profound systemic action wherein the resistance of laboratory animals is depressed to a wide variety of bacterial, viral, protozoal and fungal agents. It was of interest to ascertain whether or not the enhancement observed above might not be attributable to this generalized effect. The corticosteroid was therefore administered extraperitoneally via the intramuscular route in equivalent doses at varying periods prior to the intraperitoneal injection of bacteria or of physiological saline, both in one single dose and in a 2-day course of 3 injections daily. When the preparatory cortisone injection was administered by the extraperitoneal route no deaths occurred within 48 hr. after the intraperitoneal injection of the micro-organisms (Table 2). Those deaths that did occur came later and were the result of the toxic effect of large doses of cortisone, possibly by activation of latent intrinsic infections, since the number of deaths and the times of their occurrence were essentially the same regardless of whether bacteria had been injected. It is therefore concluded that enhancement of staphylococcal virulence for mice by intraperitoneally administered cortisone acetate is by virtue of its local rather than general effect.

No common property or factor is evident between gastric mucin, the most thoroughly investigated of the infection promotion substances reviewed by Olitzki[3,4] and those at present and previously[1] reported upon by us that might account for their virulence-enhancing capability with the possible exception of their common ability to lower surface tension significantly. The exact mechanism whereby mucin exerts its effect has not been completely established. Although it may exert a growth stimulatory effect under certain conditions[5,6], weight of evidence would seem to indicate that its action is directed primarily against the host's defence mechanism by interference with phagocytosis, intraphagocytic digestion and the bactericidal action of peritoneal fluid upon the bacteria because of their coating. Surfactants, by virtue of their surface depressive action, may similarly protect intraperitoneally injected micro-organisms from the defence reaction of

the host. Cortisone acetate, cholesterol and lecithin as well as gastric mucin in the concentrations employed are all capable of lowering surface tension, their surface tensions measuring 40·0, 37·3, 42·2 and 43·3 dynes/cm. respectively with the Fisher surface tensiometer at 25° as compared to 75·7 for physiological saline. Capability of lowering surface tension *per se* may not, however, be the only determinant since 'Tween 80', even though it lowers surface tension considerably, is incapable of enhancing bacterial virulence for mice[1].

Other factors of possible contributory significance are chemical composition, viscosity and physical state. The effective adjuvants are of varied chemical composition. Gastric mucin is a mucopolysaccharide or glucoprotein. Surfactants are chemically diverse; the anionic detergents include sulphated alcohols, paraffin, alkylaryl and petroleum sulphonates, whereas non-ionic detergents consist of polyesters and ethers formed as condensation products from fatty acids, alcohols and phenols. Lecithin, on the other hand, is a mixture of the diglycerides of stearic, palmitic and oleic acids linked to the choline ester of phosphoric acid. Bile salts, cortisone acetate and cholesterol are all steroids characterized by the cyclopenteno perhydrophenanthrene nucleus. As for viscosity, only gastric mucin of the above is significantly viscous, its relative viscosity being 2·5, as compared to the others, the relative viscosities of which measure approximately 1·0, as computed by determining efflux time from a calibrated tube of uniform bore at constant temperature. Considering physical state, while the subject adjuvants of this report and gastric mucin are suspensions containing particulate matter, bile salts mixture and the surfactants previously found effective form clear solutions. Further studies are in progress in an attempt to elucidate the mechanism whereby these chemically and physically diverse substances convert ordinarily non-lethal intraperitoneal infections in mice into rapidly fatal ones.

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Isolation of a Phagocytosis-inhibiting Substance from Culture Filtrates of an Encapsulated *Staphylococcus aureus*

Coagulase-negative strains of *Staphylococcus albus* added to suspensions of rabbit polymorphonuclear leucocytes in normal rabbit serum are rapidly phagocytosed and destroyed; in contrast, coagulase-positive strains of *Staphylococcus aureus* resist ingestion and survive extra-cellularly. The addition of anti-serum prepared against heat-killed *S. aureus* results in efficient phagocytosis and intracellular killing of the homologous organism[1]. The present communication describes the isolation and properties of a substance obtained from culture filtrates of an encapsulated *S. aureus* which interferes with its phagocytosis.

The organism utilized was *S. aureus* 'Smith' (phage type 44*A*/42*E*, hæmolytic, coagulase-positive, and mouse virulent). Bacterial cells were removed by centrifugation and filtration from 15 l. of an 18-hr. culture grown in the medium and apparatus described by Goebel *et al.*[2]. The supernatant fluid was concentrated *in vacuo* and lyophilized after dialysis against distilled water. Absolute ethanol was added to a 1 per cent solution of the material in aqueous sodium acetate. A fraction was isolated which was soluble in six but insoluble in eight volumes of ethanol. This fraction was deproteinized by repeatedly extracting a 0·5 per cent solution in 0·02 *M* acetate buffer, *p*H 5·0, with chloroform–octanol. The lower phase was then dialysed against distilled water and lyophilized.

1 gm. of white amorphous material was obtained which had the following physical and chemical properties. A 0·5 per cent solution in isotonic saline sedimented as a single peak when examined in the analytical ultracentrifuge; $S_{20} = 1·3$ Svedberg units. An essentially homogeneous boundary appeared upon free electrophoresis of a 1·0 per cent solution in veronal buffer, *p*H 8·6, ionic strength 0·1; the mobility was $-11·4 \times 10^{-5}$ cm.^{2}/volt-sec. The nitrogen and phosphorus contents were 7·4 and 0·18 per cent, respectively. Marked humin production was noted upon heating in dilute mineral acid. Analysis of hydrolysed samples revealed the presence of the following components: amino-acids—28·9 per cent (alanine—9·1 per cent, glutamic acid—6·7 per cent, lysine—6·6 per cent, aspartic acid—4·8 per cent, glycine—1·1 per cent, threonine—0·25 per cent and serine—0·25 per cent); lipid—0·0 per cent; reducing sugar—15 per cent; and hexosamine—12·4 per cent. The remainder of the carbohydrate moiety apparently consisted of one or more non-reducing sugars as yet unidentified. Neither muramic acid nor sialic acid was demonstrated.

The isolated substance reacted promptly in capillary precipitin tests, with rabbit anti-sera prepared against homologous, heat-killed organisms, but were not precipitated with normal rabbit serum. The end point occurred at a final concentration of less than 0·5 μgm./ml. At a concentration of 1 mgm./ml., a single band was formed with immune rabbit serum in double diffusion precipitin tests in agar gel. Pooled human globulin (16·5 per cent γ-globulin) also formed a single band in this reaction. Several attempts to stimulate formation of antibodies by injecting the compound into experimental animals have thus far been unsuccessful.

When immune rabbit serum against *S. aureus* 'Smith' was absorbed with the material at the equivalence point, the serum no longer agglutinated the bacterial cells. The opsonizing capacity of the absorbed serum was then compared with that of unabsorbed immune serum. Rabbit polymorphonuclear leucocytes free from erythrocytes and other leucocytes were obtained from glycogen-induced peritoneal exudates. Previously described suspending media and conditions for performing the phagocytic tests were employed[1]. Each suspension contained 10 per cent fresh normal rabbit serum to provide adequate amounts of complement.

Results from a representative experiment are presented in Fig. 1. Addition of absorbed anti-serum

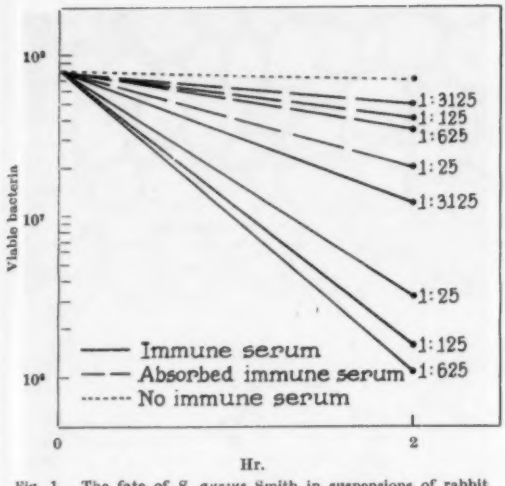

Fig. 1. The fate of *S. aureus* Smith in suspensions of rabbit polymorphonuclear leucocytes

had little effect upon bacterial survival, whereas a marked reduction in the number of viable units occurred upon addition of even small quantities of unabsorbed immune serum. Enumeration of viable bacteria in the supernatant fluid following deposition of the phagocytes by low-speed centrifugation revealed that all the viable staphylococci were free in the extracellular fluid. This observation established that the effects noted were dependent upon differences in phagocytosis and not a reflexion of intra-leucocytic survival. It was furthermore shown that agglutination of bacteria did not play a significant part in the phagocytosis assay and that the substance itself was not inherently leucotoxic.

Thus, absorption of immune serum with the purified compound isolated from the staphylococcal culture filtrate resulted in a loss of both agglutinating and opsonizing properties against the homologous organism. The biological properties and method of isolation suggest that the material is located on the bacterial surface and is perhaps of capsular nature. Experiments are in progress to determine the complete chemical composition of this substance, its occurrence in other strains of *S. aureus*, and its role in the pathogenesis of staphylococcal infection.

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MISCELLANY

Arrow Symbol in Biology

THE great value of this symbol in representing chemical reactions has tempted biologists to extend its use, in diagrams and 'schemes', to represent other activities. This in principle is far from objectionable: diagrams and schemes are very helpful and this symbol is a clear, meaningful piece of shorthand, but unfortunately so many different activities have come to be represented by it that it has more than lost in specificity what it has gained in comprehensiveness.

The representation $A \rightarrow B$ has been used with the following meanings, among others: (1) molecule A is converted to molecule B; (2) entity A produces, gives or donates entity B; (3) entity A is converted (in various senses) into entity B; (4) A induces the formation of B; (5) A stimulates or acts on B; (6) entity A causes an activity B; (7) A moves to place B, and even (8) I wish you to transfer your attention from item A to item B. When many of these occur in a single scheme or diagram the result may be as difficult to read as a long-hand text and far less precise and explicit. It can be at least confusing and at the worst grossly misleading: "holding issues even that are nothing mated", all the more insidious because readers are less critical of diagrams and may only half-recognize their own misapprehension. Indiscriminate lumping of issues that are not mated is contrary to good scientific practice and inimical to its best interests.

Ideally the symbol should undergo 'adaptive radiation' so as to convey the specificity of each significant type of activity for which it becomes indispensable. In fact, at present the irreducible number of such types probably is small enough to permit a reasonable and useful differentiation of this kind. To be reasonable and useful the variants of the symbol should readily convey their respective meanings and they should be easy both to write and to print. Also as far as possible they should evolve naturally and spontaneously, and command the general approval of usage. A minimum of suggestions therefore should be made at this juncture.

(1) The type of representation $A \rightarrow B$ naturally will continue to be used for chemical reactions, with the usual further conventions for reversible reactions; it is accepted to mean 'A produces B', and there seems no objection to extending it to entities other than molecules, provided that the action is producing, donating, giving, etc.

(2) Where complete systems of chemical reactions are to be represented, and particularly the cyclic systems so common in biology, the formulation of Baldwin[1] is admirable and has already the sanction of general usage. The simple scheme $\begin{matrix} A & & F \\ & \searrow\nearrow & \\ B & \rightarrow D & E \end{matrix}$, for example, indicates that molecules A and C interact to give B and D; D then interacts with E to give F and to restore C, which continues to react cyclically. This also has potential application to other entities.

(3) The symbol $A \Rightarrow B$, incorporating the 'equals' sign, conveniently could express a direct and total conversion or transformation of A into B. Chemists well might prefer it to the simple arrow to distinguish isomeric changes from orthodox reactions, but it is for the biologist that the distinction is particularly important. The symbol would represent ontogenetic, phylogenetic, seasonal and other transformations of any entity. The transformations are often complex by chemical standards, with much renewal of material by metabolic turnover, but in biological conceptions a persisting identity of the entity is often the main emphasis.

(4) The symbolism $A \dashrightarrow B$ usefully could represent A moves to B, the dashes pictorially representing the actual steps. It could cover affine conceptions: A is donated to B, etc., wherever movement is implied.

(5) The type of activity: A acts upon B, where A and B are entities other than molecules and not necessarily entities of the same kind, as when a hormone acts on an organ, conveniently could be represented by $A \nearrow B$, which pictorially puts A into the correct relationship. The existing use of this and other symbols in specialist branches of chemistry is not likely to cause serious confusion.

There remain a number of possible simple variants of the symbol for other distinct activities. All could be double-headed when required to represent reciprocal interactions and reversible processes. The present practice of writing the names of promoters of an activity over the shaft of an arrow should be extended and similarly the names of inhibitors, associated with short intercepts across the shaft. A convention that promotors are placed above a horizontal, and to the right of a vertical, arrow, and inhibitors on the opposite side, also seems reasonable. With advantage, authors might accept the conventions of Occam's axe in introducing new symbols; an apparently new relationship will often be covered by existing symbols or a combination of them, for example, $A \rightarrow B \dashrightarrow C$: '$A$ produces B and donates it to C'. Another convention which seems reasonable is that A, B, etc., must be entities and not activities, which are always represented by arrows. Thus the representation (6) above, namely, 'A causes an activity B', which might be the conversion of C to D, should be written $C \overset{A}{\Rightarrow} D$.

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A Simple Method for obtaining Perforated Supporting Membranes for Electron Microscopy

Supporting membranes with holes are usually used for testing the axial astigmatism of the objective lens in electron microscopy. In the case of specimens which are difficult to focus they facilitate the focusing. Supporting membranes with a large percentage of open area are of great advantage for mounting thin sections, because the gain in contrast is considerable[1]. It applies also to specimens for testing the resolving power of the electron microscope or high-resolution work, when a very thin film of collodion can be mounted on these perforated membranes[2]. The holes will then enable not only the focusing but also a continuous control of the axial astigmatism. Several methods for obtaining holes in supporting membranes have been described[2–5]. Mostly 'Formvar' film is used; but to obtain reproducible results the methods are relatively complicated.

We have developed a simple method for obtaining holes in collodion films. This method does not differ from the others in principle, as it is based on the introduction of minute water droplets into the film; but it does not require any special equipment and makes it possible to prepare the membranes or nets very quickly and in a reproducible way.

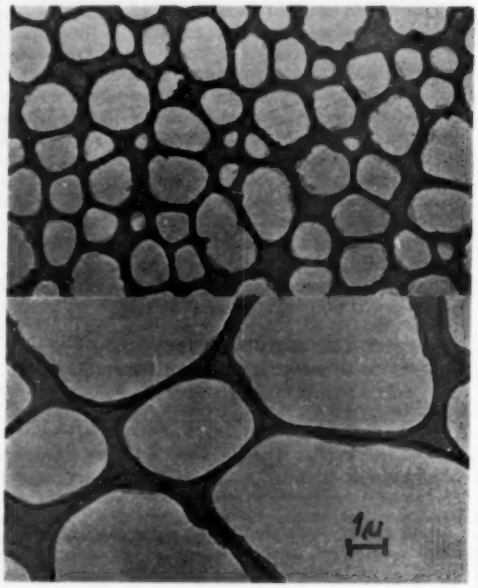

Fig. 1

A solution of 0·2–0·3 per cent collodion solution with *iso*amyl-acetate as solvent filling up about a half of a small glass vessel is used. A thoroughly mechanically cleaned microscope slide is dipped into the solution and held for about 30 sec. in a vertical position above the solution surface. Then the slide is removed from the vessel and breathed upon after some few seconds. Breathing upon the film on the slide may be repeated several times at intervals of a few seconds as long as the solution is evaporating. The forming of the film area with holes can be easily followed by observing the film, because this area has a 'foggy' appearance. According to the length and intensity of the breathing a narrower or broader strip of film with holes is formed. The film from the slide is easily floated off on to a water surface and the areas with holes are transferred to specimen grids. Before using, the film with holes is stabilized by evaporation of carbon or metal.

The size of the holes depends on the width of the 'foggy' strip. For most purposes a width of about 1·5 mm. is suitable. In a narrower strip small holes arise; in broader ones a net is formed. If the area with holes is too broad the net is likely to shrink when being floated off. Electron micrographs of holes obtained in this way are shown in Fig. 1.

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FORTHCOMING EVENTS

Monday, April 4

INSTITUTION OF ELECTRICAL ENGINEERS, ELECTRONICS AND COMMUNICATIONS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. R. V. Harvey: "V.H.F. Sound Broadcasting—Subjective Appraisal of Distortion due to Multi-Path Propagation in F.M. Reception".

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. A. E. Bingham: "Research Testing".

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the LONDON SECTION and the SURFACE ACTIVITY GROUP, at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. J. A. Kitchener: "The Physical Chemistry of Foaming".

Tuesday, April 5

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND CONTROL SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. R. W. A. Scarr and Mr. R. A. Setterington: "Thermistors—their Theory, Manufacture and Application".

SOCIETY FOR ANALYTICAL CHEMISTRY, PHYSICAL METHODS GROUP (at the Northern Polytechnic, Holloway Road, London, N.7), at 6 p.m.—Meeting on "Automatic Analytical Instrumentation".

PLASTICS INSTITUTE (at the Wellcome Building, 183–193 Euston Road, London, N.W.1), at 6.30 p.m.—Dr. J. Gadsby: "Where Plastics are Going" (Chairman's Lecture).

Wednesday, April 6

ROYAL SOCIETY OF ARTS (at John Adam Street, London, W.C.2), at 2.30 p.m.—Mr. C. S. Cockerell: "Hovercraft".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. A. M. Quennell: "The Morphology and Origin of the East African Rift System"; Prof. W. D. Evans, Dr. B. Cooper, Dr. D. W. Corbett and Mr. K. Gough: "A Geochemical Survey of the Nottinghamshire Oilfield and Related Sediments".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5 p.m.—Mr. W. F. Bodmer: "Discrete Stochastic Processes in Population Genetics".

INSTITUTE OF PETROLEUM (at 61 New Cavendish Street, London, W.1), at 5.30 p.m.—Mr. F. P. Alban: "The Systematic Prediction of Refinery Utilities".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at 14 Belgrave Square, London, S.W.1), at 6 p.m.—Mr. J. W. Jenkin: "The Presentation of Corrosion Information" (Spring Lecture).

SOCIETY FOR ANALYTICAL CHEMISTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

Wednesday, April 6—Thursday, April 7

IRON AND STEEL INSTITUTE, IRON AND STEEL ENGINEERS GROUP (at 4 Grosvenor Gardens, London, S.W.1), at 10.30 a.m. daily—Thirty-ninth Meeting. Discussion of four papers on the design and operation of Heavy Plate Mills and their auxiliary equipment.

Wednesday, April 6—Saturday, April 9

INSTITUTION OF MINING AND METALLURGY (at Church House, Westminster, London, S.W.1)—International Mineral Processing Congress.

Thursday, April 7

INSTITUTE OF REFRIGERATION (joint meeting with the LOW TEMPERATURE GROUP of the PHYSICAL SOCIETY, at the Institute of Marine Engineers, The Memorial Building, 76 Mark Lane, London, E.C.3), at 5.30 p.m.—Mr. J. D. Gurney: "Some Problems Associated with the Use of a High Speed Reciprocating Compressor for Aircraft Cooling Projects".

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Scientific Papers.

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (at 14 Belgrave Square, London, S.W.1), at 6 p.m.—Annual General Meeting followed by Scientific Papers.

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. H. A. R. Binney: "The Work of the B.S.I. in Relation to the Radio and Electronics Industry".

BRITISH INTERPLANETARY SOCIETY (in the Tudor Room, Caxton Hall, Westminster, London, S.W.1), at 7 p.m—Mr. J. Allen: "Lunar Missions and Vehicle Design".

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. W. C. J. White and Mr. D. L. Overheu: "The Electronic Computer as a Unit in an Automatic Electronic Data Processing System for Missile Trials".

Friday, April 8

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, University College, Gower Street, London, W.C.1), at 10.25 a.m.—Annual General Meeting.

INSTITUTE OF PHYSICS, NON-DESTRUCTIVE TESTING GROUP (at 47 Belgrave Square, London, S.W.1), at 6 p.m.—Mr. R. S. Sharpe: "Nuclear Fuel Element Inspection".

SOCIETY OF CHEMICAL INDUSTRY, HEAVY ORGANIC CHEMICALS GROUP (at 14 Belgrave Square, London, S.W.1), at 6 p.m.—Mr. C. D. Callieu and Mr. J. W. Fletcher: "The Handling and Transportation of Heavy Organic Chemicals".

Saturday, April 9

FORENSIC SCIENCE SOCIETY (at Guy's Hospital Medical School, London, S.E.1)—Symposium on "The Investigation of Fatal Road Accidents".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (with a good degree and suitable teaching, research or industrial experience) IN MATHEMATICS—The Principal, Brunel College of Technology, Woodlands Avenue, Acton, London, W.3 (April 9).

ASSISTANT LECTURER IN THE DEPARTMENT OF MINING—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (April 15).

PHYSICIST or ENGINEER (with a university degree or equivalent background, and several years practical experience in microwave-tube design) to become a member of an existing group for microwave-tube research—Norwegian Defence Research Establishment, Division Radar, Bergen, Norway (April 15).

TEMPORARY ASSISTANT LECTURER or LECTURER (with an honours degree in physics and a special interest in mineral preparation and other physical problems in the mining industry) IN THE DEPARTMENT OF MINING—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (April 15).

ASSISTANT SECRETARY (graduate, with administrative, industrial or scientific experience) TO THE APPOINTMENTS BOARD—Secretary to the University Council, University of Wales, University Registry, Cathays Park, Cardiff (April 16).

ASSISTANT LECTURER or LECTURER (with a special interest in climatology or meteorology) IN GEOGRAPHY; and an ASSISTANT LECTURER or LECTURER (with a special interest in physical geology or geomorphology) IN GEOLOGY at the University College of Ghana—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 20).

HYDROBIOLOGICAL RESEARCH OFFICER (Senior Lecturer or Lecturer) IN THE FACULTY OF SCIENCE, University of Khartoum—The Registrar, University of Khartoum, c/o Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 20).

LECTURER IN BACTERIOLOGY, based at the Western Infirmary, with duties at the Royal Hospital for Sick Children—The Secretary of University Court, The University, Glasgow (April 20).

LECTURER (suitably qualified graduate with experience or interest in the problems of agricultural research) IN STATISTICS—The Registrar, Wye College (University of London), near Ashford, Kent (April 21).

LECTURER (well qualified in mathematical statistics) IN THE NEW DEPARTMENT OF STATISTICS under Prof. D. V. Lindley—The Registrar, University College of Wales, Aberystwyth (April 22).

DEPUTY LIBRARIAN (graduate, preferably under 45, with senior experience in a University or National Library)—The Secretary to the Senate, University of London, W.C.1 (April 23).

ISAAC WOLFSON RESEARCH FELLOW (suitably qualified graduate aged 23–35, either British subject (from any Commonwealth country) or Israeli citizen) IN METALLURGY—The Principal, St. Edmund Hall, Oxford (April 23).

LECTURER (with a degree in a biological subject or in agriculture) IN THE DEPARTMENT OF EDUCATION—The Registrar (Room 22, O.R.B.), The University, Reading (April 23).

ASSISTANT LECTURER (with a good honours degree in either botany or agricultural botany) IN AGRICULTURAL BOTANY; an ASSISTANT LECTURER (preferably with some experience in chemical microbiology) IN AGRICULTURAL BIOCHEMISTRY; an ASSISTANT LECTURER (preferably with a special interest in algology or experimental morphology) IN BOTANY; a LECTURER IN INORGANIC CHEMISTRY; an ASSISTANT LECTURER IN CHEMISTRY; a LECTURER IN PHYSICS with special emphasis on electronics; a LECTURER IN PHYSICS; and a LECTURER or ASSISTANT LECTURER IN PURE MATHEMATICS—The Registrar, University College of Wales, Aberystwyth (April 25).

COMPUTING ASSISTANT (with an honours degree in mathematics or in a pure or applied science) IN ELECTRONIC COMPUTING—The Registrar, The University, Leeds 2 (April 25).

LECTURER or ASSISTANT LECTURER (with specialist qualifications in animal nutrition, including elementary biochemistry) IN THE DEPARTMENT OF AGRICULTURE (ANIMAL SCIENCE SECTION), University of Malaya, Kuala Lumpur—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Malaya and London, April 25).

VICE-PRINCIPAL (with good academic experience in a technology field and a leaning towards administrative work)—Clerk to the Governing Body, Battersea College of Technology, London, S.W.11 (April 25).

ASSISTANT LECTURERS (2) IN PHYSICS—The Registrar, The University, Hull (April 30).

CHAIR OF PATHOLOGY in the University of Malaya (Singapore Division)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 30).

SENIOR LECTURER or LECTURER (preferably with experience in protein fractionation or immunology) IN THE DEPARTMENT OF MICRO-

BIOLOGY, University of Adelaide, South Australia, to collaborate in a research programme directed by Prof. D. Rowley which is concerned with the biochemical factors underlying natural resistance to bacterial infections—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, April 30).

LECTURER (with a good honours degree) IN PHYSICS—The Registrar, King's College (University of London), Strand, London, W.C.2 (May 1).

UNIVERSITY LECTURER (with teaching and research experience in X-ray crystallography) IN MINERALOGY AND PETROLOGY—Dr. I. D. Muir, Department of Mineralogy, The University, Downing Place, Cambridge (May 2).

READER (with a university higher degree with high qualifications in the profession of pharmacy) IN PHARMACY at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia and London, May 7).

LECTURERS and ASSISTANTS (teaching posts) IN EXPERIMENTAL PHYSICS, THEORETICAL PHYSICS and ELECTRONICS—The Secretary, The University, Aberdeen (May 10).

SENIOR LECTURER or LECTURER IN (i) EXPERIMENTAL PHYSICS and (ii) THEORETICAL PHYSICS; a LECTURER or ASSISTANT LECTURER (preferably with a special knowledge of entomology with research interests in ecology) IN ZOOLOGY; and a LECTURER or ASSISTANT LECTURER (preferably with a special knowledge of either cytogenetics or ecology) IN BOTANY at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (May 10).

LECTURER (with an honours degree in mathematics, and preferably a higher degree, and specially qualified in some branch of applied mathematics) IN MATHEMATICS, at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia and London, May 13).

ASSISTANT LECTURER (Temporary) (man or woman graduate) IN PHYSICS—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (May 14).

POSTDOCTORAL FELLOWS (one or two), for research on a variety of problems in organic chemistry—The Administrative Officer, Dyson Perrins Laboratory, The University, South Parks Road, Oxford (May 14).

SENIOR RESEARCH OFFICER (mathematician or physicist with two years research experience in the field of numerical analysis or applications of automatic computing machines)—The Director, University Computing Laboratory, 9 South Parks Road, Oxford (May 21).

CHAIR OF MATHEMATICS in the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa and London, May 31).

CHALLIS CHAIR OF ZOOLOGY; and McCAUGHEY CHAIR OF GEOGRAPHY in the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia and London, May 31).

FERRANTI FELLOW (with at least two years research experience) IN COMPUTING at the Oxford University Computing Laboratory, to do original work in any field connected with computation or the application of digital computers—The Director, University Computing Laboratory, 9 South Parks Road, Oxford (July 31).

ASSISTANT EXPERIMENTAL OFFICER (graduate in botany, horticulture or forestry) IN THE STATISTICS SECTION, to study field experimentation with fruit trees and bushes and to help with the advisory work of the Section—The Secretary, East Malling Research Station, near Maidstone, Kent.

ASSISTANT LECTURER, Grade B (university graduate in physics, with research and/or teaching experience) IN PHYSICS; and a LECTURER (with good academic qualifications in chemistry together with industrial and/or research experience) IN SURFACE COATINGS TECHNOLOGY—Clerk to the Governing Body, Borough Polytechnic, Borough Road, London, S.E.1.

BIOCHEMIST (Basic grade)—Dr. Walker, Biochemistry Department, Royal National Orthopaedic Hospital, Stanmore, Middlesex.

BIOCHEMIST (Basic grade) (graduate in chemistry or Associate or Graduate Member of the Royal Institute of Chemistry) IN THE DEPARTMENT OF PATHOLOGY—The Group Secretary, Queen Elizabeth Hospital for Children, Hackney Road, London, E.2.

BIOCHEMIST (Senior grade), to take charge at the East Riding Group Laboratory—The Secretary, Westwood Hospital, Beverley, East Yorkshire.

CHEMIST or BIOCHEMIST (with a good honours degree in chemistry or biochemistry, and preferably postgraduate experience) IN THE RADIOCHEMISTRY DEPARTMENT, for biochemical research involving the use of radioactive isotopes and in particular C^{14} and tritium—The Secretary, National Institute for Research in Dairying (University of Reading), Shinfield, Reading, quoting Ref. 60/3.

LABORATORY STEWARD (with experience in chemistry laboratory techniques) IN THE PHARMACY AND PHYSIOLOGY DEPARTMENT—The Registrar, Portsmouth College of Technology, Portsmouth.

LECTURER IN CHEMISTRY; a LECTURER (preferably with postgraduate experience in one of the following: numerical analysis, statistics or mathematical physics) IN MATHEMATICS; and a LECTURER (preferably with experience in one of the following: electronics, microwave techniques or solid state physics) IN PHYSICS—The Registrar, Portsmouth College of Technology, Portsmouth.

LECTURERS IN MATHEMATICS, ORGANIC CHEMISTRY, GEOLOGY, PHYSICS, PHYSICAL CHEMISTRY AND BIOLOGY—The President, University College, P.O.B. 399, Addis Ababa, Ethiopia.

LECTURER (man or woman) IN CHEMISTRY—The Principal, Studley College, Warwickshire.

LIBRARIAN (with a degree, preferably but not necessarily, in science)—The Director, Scottish Marine Biological Association, Marine Station, Millport, Isle of Cumbrae, Scotland.

SCIENTIFIC AND TECHNICAL INFORMATION OFFICER (preferably with a chemistry, engineering or physics degree, or at least G.C.E. at "A" level, H.N.C., or equivalent qualifications), to assist in providing a scientific and technical information service related to the Establishment's research programme—Group Recruitment Officer (1635/34), U.K.A.E.A., A.E.R.E., Harwell, Didcot, Berks.

SENIOR AGRONOMIST (with a degree in agriculture or in natural science with a postgraduate diploma in agriculture, and considerable experience in field experimentation, preferably with perennial tree crops) at the West African Cocoa Research Institute, Ghana, to take charge of the Agronomy Section and co-operate with senior specialist officers in the field experimental work of the Institute—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.197/200/010/C1.

TSETSE OFFICER (preferably under age 25, with an honours degree in a biological subject) in Tanganyika, for tsetse survey and clearing work and to advise on reclamation measures—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.67/8/011/C1.

REPORTS and other PUBLICATIONS

(Not included in the monthly Books Supplement)

Great Britain and Ireland

The University of Hull. Annual Report, 1958–1959. Pp. 81. (Hull: The University, 1959.)

Department of Scientific and Industrial Research. D.S.I.R. Studentships and Fellowships. Pp. 24. 1*s.* 6*d.* net. D.S.I.R. Research Grants. Pp. iv+10. 1*s.* 3*d.* net. (London: H.M. Stationery Office, 1960.) [261

Ministry of Power: Safety in Mines Research Establishment. Safety in Mines Research 1958: Thirty-seventh Annual Report. Pp. 71+4 plates. (London: H.M. Stationery Office, 1960.) 5*s.* net. [261

Planning, Vol. 26, No. 438 (25 January 1960): America and the Welfare State. By Dorothy Wilson. Pp. 1–36. (London: Political and Economic Planning, 1960.) 5*s.* [261

B.B.C. Engineering Monograph No. 27: The Equipment of the B.B.C. Television Film Studios at Ealing. By N. F. Chapman. Pp. 31. (London: British Broadcasting Corporation, 1960.) 5*s.* [261

The Mond Nickel Co., Ltd. The Case-Hardening of Nickel Alloy Steels. Pp. 36. (London: The Mond Nickel Company, Ltd., 1960.) [261

Other Countries

Transactions of the American Philosophical Society. New Series, Vol. 49, Part 7: Bernard de Fontenelle—The Idea of Science in the French Enlightenment. By Prof. Leonard M. Marsak. Pp. 64. (Philadelphia: American Philosophical Society, 1959.) 1.50 dollars. [261

Companhia de Diamantes de Angola (DIAMANG). Servicos Culturais. Dundo—Lunda—Angola. Museu do Dundo. Subsidios para o Estudo da Biologia na Lunda. Publicacoes Culturais No. 46 (Separata): Nouvelles Contributions à l'Étude Systématique et Biogéographique des Glossines (Diptera). Par A. de Barrod Machado. Pp. 13–90. (Lisboa: Companhia de Diamantes de Angola, 1959.) [261

United States Department of Commerce: Coast and Geodetic Survey. Technical Bulletin No. 8: Mathematical Basis of Analytic Aerotriangulation. By G. C. Tewinkel. Pp. ii+9. (Washington, D.C.: Government Printing Office, 1959.) 15 cents. [261

United States Department of the Interior: Fish and Wildlife Service. Fishery Bulletin No. 162: Variability of Skipjack Response to Live Bait. By Henry S. H. Yuen. Pp. iv+147–160. 20 cents. Fishery Bulletin No. 164: Food of the Pacific Sardine (*Sardinops caerulea*). By Cadet H. Hand and Leo Berner, Jr. Pp. iv+175–185. 15 cents. (Washington, D.C.: Government Printing Office, 1959.) [261

University of Pennsylvania. The 75th Anniversary of the School of Veterinary Medicine. Proceedings of the Anniversary Convocation, October 3, 1959. The Anniversary Chairman's Report. Pp. 22. (Philadelphia: University of Pennsylvania, 1959.) [261

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série Scientifique, No. 81: Détermination de la Digestibilité des Herbages Frais. Par A. Scaut. Pp. 86. 100 francs. Série Technique, No. 58: La Présélection des Demenceaux en Hévéaculture. Par E. Evers. Pp. 63+8 photographies. 50 francs. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1959.) [261

Report and Accounts of the National Botanic Gardens of South Africa (Kirstenbosch, Newlands, Cape, and The Karoo Garden, Worcester) for the financial year ended 31 March 1959. Pp. 24. (Kirstenbosch, Newlands: National Botanic Gardens, 1959.) [261

Meddelanden från Statens Skogsforskningsinstitut, Band 48, 1958–1959. (Report of the Forest Research Institute of Sweden, Vol. 48, 1958–1959). Pp. 548. (Stockholm: Statens Skogsforskningsinstitut, 1959.) [261

Indian Forest Leaflet No. 162 (New Series): Calibration of Moisture Meters for Veneers, Part 1. By B. I. Bali and M. A. Rehman. Pp. 7. (Delhi: Manager of Publications, 1959.) Rs. 1.87; 2*s.* 9*d.* [261

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